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NATIONAL DAM INSPECTION PROGRAM. MARSHWOOD DAM (NDI ID NUMBER P--ETC(U)
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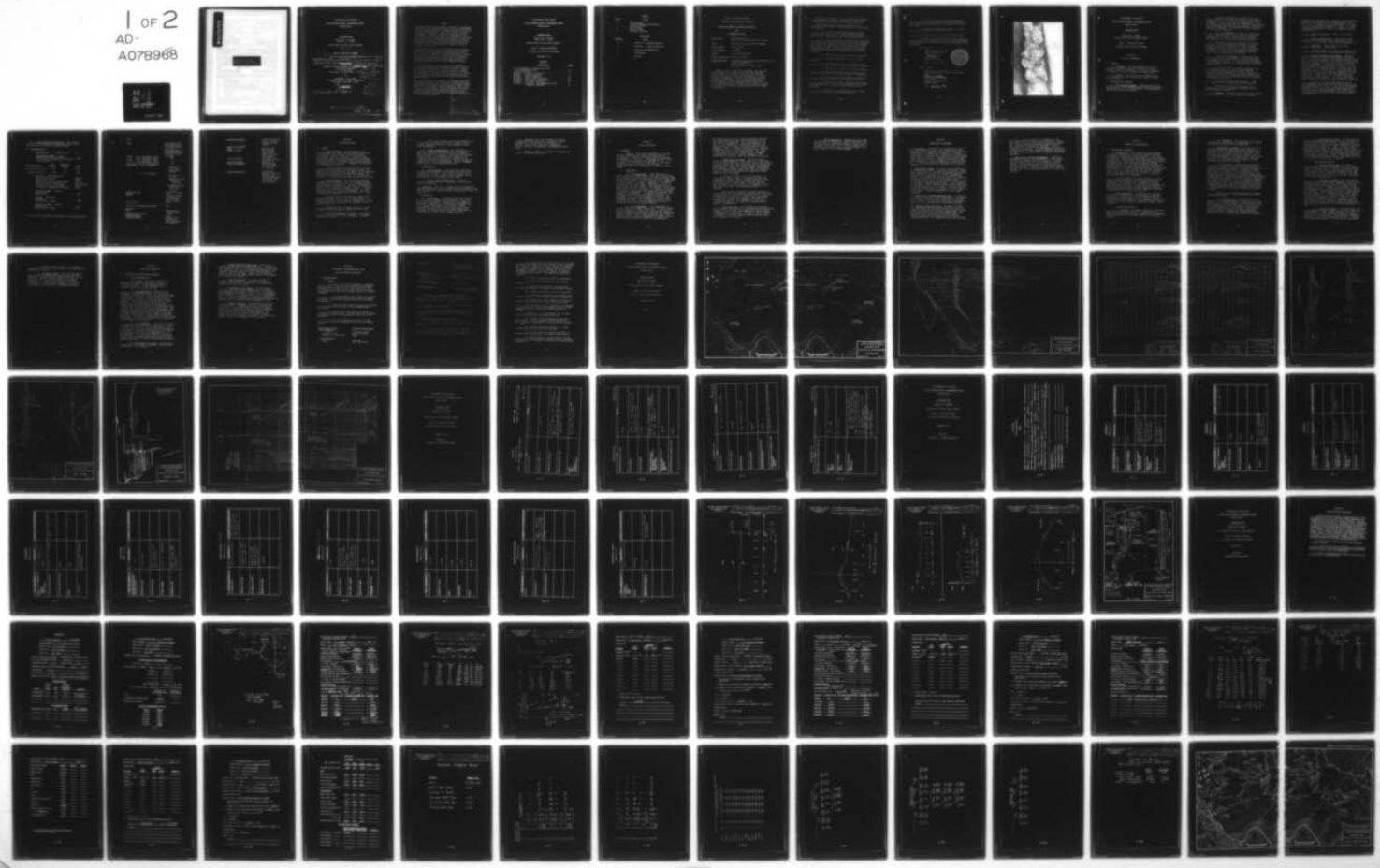

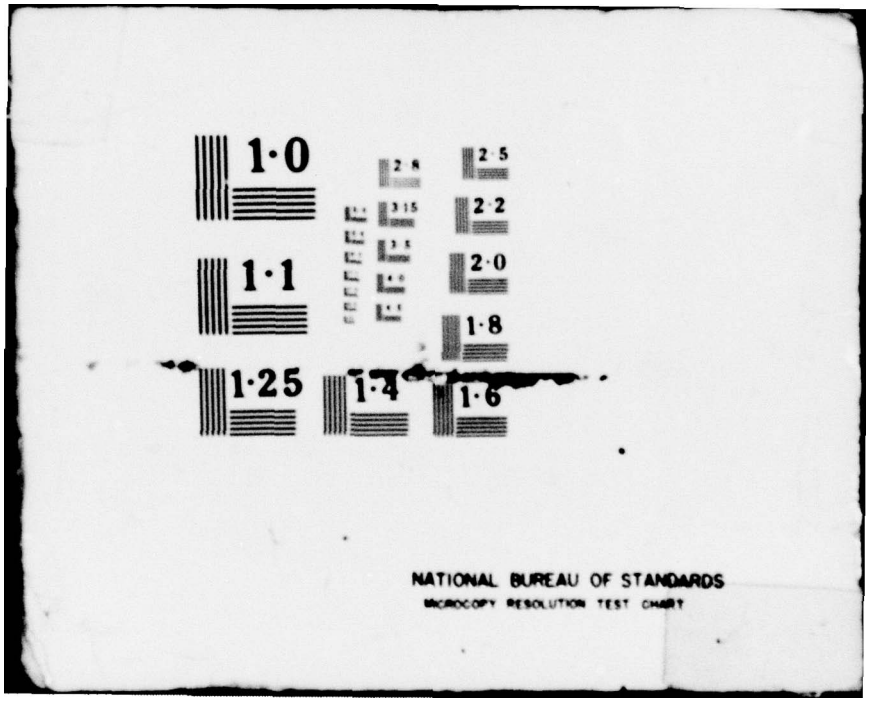
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SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88

PENNSYLVANIA GAS AND WATER COMPANY

(12) 105

Number

Number

(6) PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM. Marshwood Dam (NDI ID PA-00365, DER ID 35-88), Susquehanna River Basin, Little Roaring [redacted] Brook, Lackawanna County, Pennsylvania

Phase I Inspection Report.

GANNETT FLEMING CORDDRY AND ~~CARPENTER, INC.~~
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(11) FEB[redacted]79

(15) DACW31-79-C-0015

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

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2	South embankment and spillway
3	Typical sections
4	Outlet works
5	As-built plan
6	Auxiliary spillway

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A	Checklist - Engineering Data.
B	Checklist - Visual Inspection.
C	Hydrology and Hydraulics.
D	Photographs.
E	Geology.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Marshwood Dam NDI ID No. PA-00365/DER ID No. 35-88
Owner:	Pennsylvania Gas and Water Company
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	Little Roaring Brook
Date of Inspection:	25 October 1978
Inspection Team:	Gannett Fleming Corddry and Carpenter, Inc. Consulting Engineers P.O. Box 1963 Harrisburg, Pennsylvania 17105

[cont'd from page 2]

Based on visual inspection, available records, calculations and past operational performance, Marshwood Dam is judged to be in fair condition. The spillway can pass 65 percent of the Probable Maximum Flood (PMF) without overtopping of the dam. The spillway capacity is rated as inadequate. This rating is dependent on implementation of some of the recommendations herein. If the low areas on the embankments were raised 0.6 foot to the design elevation, the spillway can pass 80 percent of the PMF. The spillway capacity would still be rated as inadequate.

There is no evidence of serious stability problems on the embankment; however, the amount of brush on the embankment precluded a definitive visual inspection.

The following measures are recommended to be undertaken by the Owner, in approximate order of priority, immediately:

(1) Clear the auxiliary spillway banks and approach of trees and brush. The auxiliary spillway should then be surveyed to determine its existing bedslope and template. Take appropriate action as required.

(2) Remove brush and trees that are in the main spillway outlet channel and that are on or near the embankment. When the brush and trees are removed, the embankment should be inspected on a regular basis to check for wet areas or seepage. After the brush is removed, the embankments should be inspected in detail to determine if any deficiencies exist. Take appropriate action as required.

(3) Repair the gouge on the South Embankment.

(4) Raise the embankments to their design elevation.

(5) Repair the wire mesh in the main spillway outlet channel and the riprap in the approach channel.

(6) Repair the concrete in the stilling basin.

(7) Investigate the pipe in the reservoir and adequately plug it, if it extends through the embankment.

(8) Ensure that proper plugs are available for upstream closure facilities on the outlet works pipe.

(9) Undertake a study to determine the adequacy of the access to the outlet works during periods of high spillway discharge. Undertake remedial measures as required.

In addition, it is recommended that the Owner modify his operational procedures as follows:

(1) Develop a detailed emergency operation and warning system for Marshwood Dam and Dunmore No. 4 Dam. A similar recommendation is being made for Dunmore No. 3 Dam.

(2) Modify snowplowing operations to avoid removing material from the top of the dam.

(3) Provide round-the-clock surveillance of Marshwood Dam during periods of unusually heavy rains.

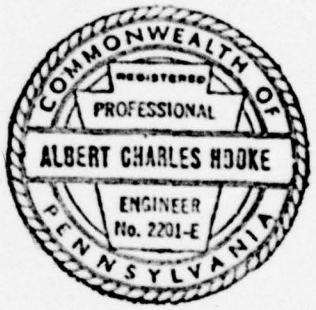
(4) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

A. C. HOOKE
Head, Dam Section

Date: 9 March 1979



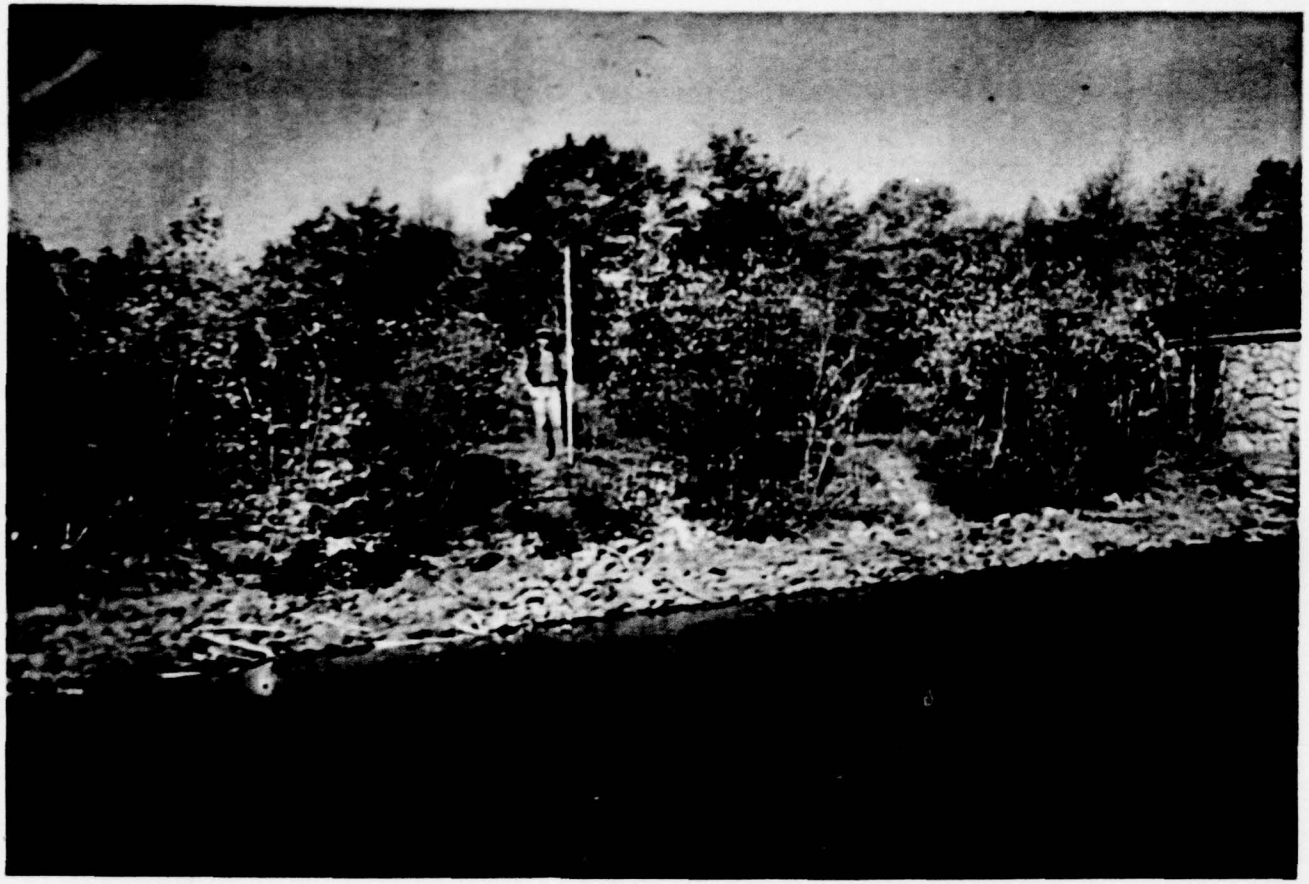
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE: 28 Mar 79

MARSHWOOD DAM



Overview

SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88
PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Marshwood Dam is two homogeneous earthfill embankments with masonry core-walls. The dam was built in a natural saddle. The embankments impound water within the saddle.

The North Embankment is about 850 feet long. It has a topwidth of 10 feet and upstream and downstream slopes of 1V on 1.5H and 1V on 2H, respectively. The embankment is about 7 feet high at maximum section, and it prevents water from flowing into the Eddy Creek Watershed. Little Roaring Brook flows into the reservoir at the east end of the embankment. No spillway or outlet works is provided in the embankment.

The South Embankment is about 370 feet long. It has an upstream slope of 1V on 2H and a topwidth of 10 feet. The downstream slope is 1V on 1.5H above elevation 1537.1, and 1V on 10H below that elevation. The embankment is 14 feet high at maximum section.

The dam has a main spillway and an auxiliary spillway. The main spillway is located at the right abutment of the South Embankment. It has a sharp-crested concrete weir with a crest length of 100 feet. The crest is 4.4 feet below the design top elevation of the dam. A concrete stilling basin with baffle blocks is located downstream of the weir.

The auxiliary spillway is a canal about 300 feet left of the South Embankment. The upstream invert of the auxiliary spillway is 4.2 feet below the design top elevation of the dam. The canal has a bottom width of 25 feet, approximately 1V on 1.5H side slopes, and a bed slope of 0.001.

[cont'd on pg a-1]

The outlet works is located at the left end of the main spillway. It is an 18-inch diameter cast-iron pipe extending from an intake structure to the natural channel downstream. A valve contained within a valve pit controls the discharges from the pipe. An abandoned water supply line is located directly adjacent to the outlet works pipe.

The stream flowing from Dunmore No. 3 and No. 4 Dams enters at the east side of the reservoir.

The various features of Marshwood Dam are shown on the Plates at the end of the report and on the Photographs in Appendix D.

b. Location. The dam is located on Little Roaring Brook approximately 2.5 miles northeast of Dunmore,

Pennsylvania. Marshwood Dam is shown on USGS Quadrangle, Olyphant, Pennsylvania, with coordinates N41° 25'55" - W75° 33'45" in Lackawanna County, Pennsylvania. The dam is 2.2 miles upstream of Dunmore No. 1 Dam. It is also 1.3 miles downstream of Dunmore No. 3 Dam and 1.5 miles downstream of Dunmore No. 4 Dam. The location map is shown on Plate 1.

c. Size Classification. Small (14 feet high, 286 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Marshwood Dam (Paragraph 5.1c.).

e. Ownership. Pennsylvania Gas and Water Company, Wilkes-Barre, Pennsylvania.

f. Purpose of Dam. Water supply for Dunmore, and Dickson City, Pennsylvania and surrounding communities.

g. Design and Construction History. Marshwood Dam was built by the Scranton Gas and Water Company in 1927. As originally planned, the present auxiliary spillway, at the South Embankment, was the main spillway and an auxiliary spillway was to be constructed in the middle of the North Embankment. Immediately after construction, the North Embankment settled about 1.5 feet. It is uncertain whether the planned auxiliary spillway was built. If it were, it was removed in 1927. In either case, an irregular channel that was used as an auxiliary spillway existed at the west end of the North Embankment by the end of 1927. During 1928, the North Embankment was raised to its design elevation. In 1933, the dam was overtopped by a small amount. The Pennsylvania Water Supply Commission ordered the spillway capacity increased.

In 1946, the present main spillway in the South Embankment was constructed and the spillway in the North Embankment was filled. At this time, both embankments were raised by 1.4 feet, the slopes were modified, the water supply line was abandoned and plugged, and the outlet works pipe was extended. The Contractor for this work was the Banks and Futch Construction Company of Wilkes-Barre.

h. Normal Operational Procedure. The reservoir is normally maintained at spillway crest level. The valve on the outlet works is usually closed.

1.3 Pertinent Data.

a. Drainage Area.[1] (square miles) 1.6

b. Discharge at Damsite. (cfs.)

Maximum known flood at damsite	1,000
Outlet works at maximum pool elevation (approximate)	25

Spillway Capacity	Main Spillway	Auxiliary Spillway	Total
At existing elevation	2,300	400	2,700
At design elevation	2,860	530	3,390

c. Elevation. (Feet above msl.)

Top of dam (low area)	1540.8
Design top of dam	1541.4
Maximum pool (top of dam low area)	1540.8
Normal pool (main spillway crest)	1537.0
Upstream invert outlet works	not available
Downstream invert outlet works	1527.0
Streambed at downstream toe of dam	1527.0

d. Reservoir Length. (Miles.)

Normal pool	0.42
Maximum pool	0.42

e. Storage. (Acre-feet)

Normal pool	113
Maximum pool (design)	286

f. Reservoir Surface. (Acres.)

Normal pool	37.0
Maximum pool (design)	41.5

[1] See Section 5 regarding a discussion on the drainage area.

g. Dam.

Type -	North Embankment - Homogeneous earth-fill with masonry core-wall. South Embankment - Homogeneous earth-fill with masonry core-wall.
Length - North Embankment (feet)	850
South Embankment (feet)	370
Height - North Embankment (feet)	7
South Embankment (feet)	14
Top Width (feet-both embankments).	10
Side slopes - North Embankment	
- Upstream	1V on 1.5H
- Downstream	1V on 2H
- South Embankment	
- Upstream	1V on 2H
- Downstream above elevation	1537.1-1V on 1.5H
- Downstream below elevation	1537.1-1V on 10H
Impervious core	Masonry core-wall
Zoning	None
Cutoff	Core-wall foundation excavated below natural ground surface.
Grout curtain	None

h. Diversion and Regulating Tunnel. None

i. Spillway.

Type	Sharp-crested concrete weir.
Length of weir (feet)	100
Crest elevation	1537.0
Upstream channel	Adverse 1V on 5H slope for short distance to reservoir.

	Downstream channel	Concrete stilling basin. Natural channel is downstream.
	Auxiliary Spillway	
	Type	Earthen canal
	Length of weir	None, canal has a 25-foot bottom width and 1V on 1.5H side slopes.
	Crest Elevation	Upstream invert at elevation 1537.2
	Upstream Channel	Reservoir
	Downstream Channel	Canal extends on a bed-slope of 0.001 until it runs out.
j.	Regulating Outlets	One 18-inch diameter cast-iron pipe with one 18-inch gate valve. Located in valve pit at left of main spillway.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Some engineering data were available for review for the original structures. In the Report upon the application by the Owner to construct the dam, dated 1926, the Pennsylvania Water Supply Commission prepared an account of design concepts, geology, construction materials and methods, and design features. The Report also included analyses for hydrology and hydraulics. A summary of the results of the analyses are on file.

The construction specifications for the 1946 modification are available in the Owner's files. An analysis of this modification was made by the Pennsylvania Water Supply Commission before issuing a permit. The results of the analysis is on file. No information pertinent to the modifications made in 1927 is on record.

b. Design Features. The dam and appurtenances are described in Paragraph 1.2a. The design features are shown on the Plates at the end of the report and on the Photographs in Appendix D. The South Embankment is shown on Plate 2 and on Photographs A and E. A typical section of the embankment is shown on Plate 3. Plate 5 shows another plan of the South Embankment, with modifications apparently made during construction. This is discussed in Section 6.

The main spillway is shown on Plates 2 and 3 and on Photographs A, B, C, and D. The auxiliary spillway is shown on Plate 6 and on Photograph F. There is conflicting data concerning this spillway, as discussed in Section 5.

The outlet works is shown on Plate 4. This plate was prepared before the outlet works pipe was extended in 1946, as shown on Plate 2.

The North Embankment is shown on Photograph G. No plan was available for this embankment. A typical section is on Plate 3.

Plate 3 was prepared for the 1946 modification to the dam. Although no core-wall is shown on the typical embankment sections, it was probably omitted from the drawings.

c. Design Considerations. The available information indicates that the bottom of the masonry core-wall is at elevation 1528 for the South Embankment. This is estimated to be about 3 feet below the original ground surface. No information was available concerning the foundation conditions. Neither was information available concerning the core-wall foundation conditions at the North Embankment. Present standards would require a more substantial cutoff.

2.2 Construction.

a. Data Available. No construction data were available for review for the original structures or for the 1927 modifications. Some construction data were available for the 1946 modifications. However, it was not pertinent to the purposes of this Report.

b. Construction Considerations. Since construction data is limited, construction considerations cannot be assessed.

2.3 Operation. There are no formal records of operation. Based on information from the Owner and the caretaker of the dam, all structures have performed satisfactorily, except as noted herein.

2.4 Evaluation.

a. Availability. Engineering data was provided by the Division of Dams and Encroachments, Bureau of Water Quality Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER), and by the Owner, Pennsylvania Gas and Water Company. The Owner made available a senior construction supervisor for information during the visual inspection. The Owner also researched his files for additional information upon request of the inspection team.

b. Adequacy. The type and amount of design data and other engineering data is limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The overall appearance of the dam was fair, with some deficiencies as noted herein. The locations of some of these deficiencies are shown in Appendix B on Plate B-1. Survey data acquired during this inspection is presented in Appendix B. On the day of the inspection, the pool was 1.9 feet below the spillway crest elevation. The pool was being drawn down to fill Dunmore No. 1 Reservoir downstream.

b. Embankment

(1) South Embankment. This embankment is in fair condition. Heavy brush covers most of the embankment. Young trees are growing on the upstream slope. Many of the features shown on the Plates could not be identified because of the brush. The left abutment of the embankment is very indistinct, although it appeared to be beyond the point shown on the Plates. Immediately left of the valve house, a 10-foot length of the upstream slope is gouged, with bare soil exposed. The topwidth of the embankment is only 5 feet at the gouge. No evidence of sliding was observed at the gouge. No seepage was observed downstream of the embankment. The survey performed for this inspection revealed that the embankment slopes are in accordance with the available design information. At the gouge, the top of the embankment is 0.6 foot below the design elevation. For the remaining portion, the elevation of the top of the embankment varies about 0.2 foot above and below the design elevation.

(2) North Embankment. This embankment is in fair condition. Except for the top, the entire embankment is covered with fairly heavy brush. A survey made for this inspection revealed that the upstream slope is slightly steeper than the design slope and the downstream slope is slightly flatter than the design slope. The elevation of the top of the embankment is almost entirely below the design elevation except at the abutments.

The lowest area is 0.5 foot below the design elevation. Little Roaring Brook flows into the reservoir at the east end of the embankment. This area appeared to be low, but the topography is uneven and a definite conclusion could not be made. Soil was deposited on the embankment slopes. The Owner reported that it had been pushed from the top of dam while plowing snow. There is a swamp along most of the downstream toe. The swamp is quite extensive and has standing water throughout. No seepage was observed. However, because of the swamp, the observations cannot be considered conclusive.

c. Appurtenant Structures. The outlet works appears in good condition. On the day of the inspection, the outlet works pipe was flowing half full as the reservoir was being drawn down. Both the outlet works pipe and the abandoned water supply pipe extend through the embankment under pressure. Access to the valve house, which serves only the abandoned water supply pipe, was not available. Access to the outlet works would be impossible during higher spillway discharges.

The main spillway is in fair condition. In the approach channel, some of the riprap has been dislodged near the weir. There is severe spalling on some of the baffle blocks and on three areas of the wall. Downstream of the stilling basin, the wire mesh that once contained the stone protection is completely pulled away from the stones. The downstream channel is overgrown.

The auxiliary spillway is in fair condition. A survey made for this inspection revealed that the bottom width is 25 feet and the side slopes are about 1V on 1.5H, as measured at one location. The bottom of the channel is clear and the banks are overgrown. The approach to the auxiliary spillway is overgrown with trees up to 2 inches in diameter. The auxiliary spillway does not appear to be maintained.

d. Reservoir Area. The reservoir has generally gentle slopes. The watershed is uninhabited and undeveloped. It is owned and controlled by Pennsylvania Gas and Water Company. A rusted pipe, which appears to extend through the embankment, was observed. The pipe is about 6-inches in diameter. The Owner surmised that the pipe may have once extended to a colliery.

e. Downstream Channel. Immediately downstream from the dam, the channel is slightly overgrown. The channel continues downstream through a steep, wooded and undeveloped valley for 2.2 miles to Dunmore No. 1 reservoir. The access road to the dam extends to the right abutment of the South Embankment.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at spillway crest, Elevation 1537.0, with excess inflow discharging over the spillway and into Little Roaring Brook, which flows into Dunmore No. 1 Reservoir 2.2 miles downstream. A 18-inch diameter cast-iron pipe discharges water from the reservoir. Streamflows in Little Roaring Brook can be increased by releases from Marshwood Dam. Since streamflow is usually augmented only when Dunmore No. 1 Reservoir is below spillway crest elevation, the valve on the Marshwood water discharge line is usually closed.

4.2 Maintenance of Dam. The dam is visited weekly by a caretaker who records the reservoir elevation. Weekly reports are mailed to the Owner's Engineering Department. This information is used by the Owner's Engineering Department for regulating flows in the distribution system. The caretaker is also responsible for observing the general condition of the dam and appurtenant structures and for reporting any changes or deficiencies to the Owner's Engineering Department. A Pennsylvania Gas and Water Company engineer makes a formal inspection of the dam each year, and the records are filed and used for determining priority of repairs. Informal inspections are also made when the engineer is on the site for other reasons. Brush is apparently cut when deemed necessary.

4.3 Maintenance of Operating Facilities. The valve on the outlet works pipe is operated annually. In response to the Phase I Dam Inspection Program of the previous year, the Owner is revising his maintenance procedures. Details of the procedures are still being developed.

4.4 Warning Systems in Effect. The Owner furnished the inspection team with a verbal description of the chain of command for Marshwood Dam and of a generalized emergency notification list that is applicable for all of the Pennsylvania Gas and Water Company dams. The Owner said that during periods of heavy rainfall, available personnel are dispatched to the dams to observe conditions. All company vehicles are equipped

with radios, and the personnel can communicate with each other and with a central control facility. Evaluation of risk is made by the Owner's Engineering Department. The Owner's Engineering Department is also responsible for notification of emergency conditions to the local authorities. Detailed emergency operational procedures have not been formally established for Marshwood Dam, but are as directed by the Owner's Engineering Department.

4.5 Evaluation of Operational Adequacy. Judging by the amount of brush on the embankments, a more frequent brush cutting schedule would be warranted. The maintenance procedures for the outlet works valve appear adequate. The procedures used by the Owner for inspecting the dam are adequate, but some needed repairs have not been made. In general, the warning system is adequate, but it would be more effective if it were more detailed.

SECTION 5

HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Some design data were available for review. During 1926, a report on the dam was made by the Pennsylvania Water Supply Commission. This study estimated the combined main and auxiliary spillway capacity at 1,000 cfs. The main spillway was modified to its present configuration in 1946 after the dam was overtopped in 1933. The Pennsylvania Power Commission estimated the main spillway capacity at 2,720 cfs and the auxiliary spillway capacity at 230 cfs during their analysis of the 1946 modifications. The combined spillway capacity was estimated at 2,950 cfs, for 4 feet of head over the main spillway crest. The total design spillway capacity of 3,390 cfs used in this Report was based on 4.4 feet of head over the main spillway crest (Appendix C).

The USGS mapping for Marshwood Dam is in error. Where Little Roaring Brook flows into the reservoir, a stream is shown flowing out of the reservoir and into Eddy Creek. The drainage area obtained from the USGS maps must remain doubtful. As some previous drainage areas were calculated only on the uncontrolled area, and the figures vary substantially, the most reasonable drainage area obtained from the USGS map was used.

b. Experience Data. The Owner has not reported any hydraulic problems with the dam since the 1946 modifications. He does not have any experience data concerning flows during times of flood. However, based on the spillway capacity before the dam was modified, the overtopping in 1933 would indicate a flood of record of about 1,000 cfs.

c. Visual Observations.

(1) General. The visual inspection of Marshwood Dam, which is described in Section 3, resulted in a number of observations relevant to hydraulics and hydrology. These observations are evaluated herein for the various features.

(2) Embankment. The low areas on the top of the dam reduce the spillway discharge capacity. Better snowplowing procedures would be warranted.

d. Appurtenant Structures. The condition of the wire mesh at the main spillway channel indicates an erosion hazard exists downstream of the stilling basin. The brush in this channel will raise tailwater. This will not cause a backwater effect on the weir, but it may cause overtopping of the channel banks, which would be an erosion hazard for sustained flows in the main spillway. The dislodged riprap upstream of the weir may have been caused by ice floes.

The conditions at the auxiliary spillway are of concern. The approach area and the banks of the canal are overgrown to an extent that would significantly decrease the discharge capacity. Although the banks of the canal are earthen, the low velocities in this type of spillway should not be an erosion hazard. The design information available for review and measurements obtained for this inspection indicate that the bottom width of the auxiliary spillway is 25 feet. Plate 6 indicates that the bottom width is 16 feet. Although the capacity must remain as uncertain, it has been computed using a 25-foot bottom width. The Owner stated that an in-house diving capability and various size plugs are available to provide upstream closure for the outlet works. This is deemed adequate, if the proper size plug is readily available.

Except for the pipes extending under pressure through the embankment, no deficiencies were observed at the outlet works.

(3) Reservoir Area. The pipe that was observed in the reservoir area has a potential to be under pressure through the embankment. The assessment of the dam is based on existing conditions, and the effects of future development are not considered. Relevant data concerning Dunmore No. 4 Dam is given in Appendix C. A Phase I Inspection Report for the National Dam Inspection Program is concurrently being prepared for Dunmore No. 3 Dam. Relevant data is given in Appendix C.

(4) Downstream Conditions. No conditions were observed immediately downstream of the dam that might present significant hazard to the dam. The downstream conditions indicate that the only hazard presented by the dam is the hazard to Dunmore No. 1 Dam. A Phase I Inspection Report for the National Dam Inspection Program is concurrently being prepared for Dunmore No. 1 Dam, which is of intermediate size. Dunmore No. 1 Dam is classified as high hazard. As the failure of Marshwood Dam could cause the overtopping of Dunmore No. 1 Dam, a high hazard classification is warranted for Marshwood Dam. The condition of the access road to Marshwood Dam is adequate.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE) for the size (Small) and hazard potential (High) of Marshwood Dam, the spillway design flood (SDF) is between one-half of the probable maximum flood (PMF) and the PMF. Because Dunmore No. 1 Dam, 2.2 miles downstream, has a SDF equal to the PMF, the PMF is selected as the SDF for Marshwood Dam.

(2) Description of Model. The watershed was modeled with the HEC-1DB computer program. The HEC-1DB computer program computes a PMF runoff hydrograph and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. The PMF component inflow to Dunmore No. 3 Reservoir was determined and routed through the dam and downstream. This was combined with the PMF component inflow to Dunmore No. 4 Reservoir that had been routed through Dunmore No. 4 Dam and downstream. The combined outflow from Dunmore No. 3 and No. 4 Dams was routed downstream to Marshwood Reservoir and added to the uncontrolled PMF inflow component to Marshwood Reservoir. The combined inflows were routed through Marshwood Dam. Identical methods were used for various percentages of the PMF.

(3) Summary of Results. Pertinent results are tabularized at the end of Appendix C. The analysis reveals that Dunmore No. 3 Dam upstream can pass the 1/2 PMF component but not the PMF component without overtopping. Dunmore No. 4 Dam can pass the PMF component. Marshwood Dam, with its existing top elevation of 1540.8, can pass approximately 65 percent of the PMF without overtopping.

If Marshwood Dam were raised to its design elevation of 1541.4, it would be able to pass approximately 80 percent of the PMF.

(4) Spillway Adequacy. The criteria used to rate the spillway adequacy of a dam are described in Appendix C. Because Marshwood Dam can pass the 1/2 PMF but not the PMF, the spillway capacity is rated as inadequate. If the dam were raised to its design elevation, the spillway capacity would still be rated as inadequate. This rating is dependent upon the Owner improving conditions in the auxiliary spillway.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Marshwood Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for various features.

(2) South Embankment. Brush and trees growing on the embankment and at the toes are undesirable. Because of the brush, the inspection cannot be considered definitive. Plate 2 indicates that the left abutment is about 250 feet from the spillway. Plate 5 indicates that it is over 300 feet from the spillway. From the data collected during the field inspection, Plate 5 appears to be more correct. Plate 5 and the survey information in Appendix B also indicate that the lower portion of the downstream slope is 1V on 10H. Plate 2 does not show this slope. The gouge in the upstream slope leaves the embankment with a reduced topwidth and no upstream slope protection. The Owner described this area as looking like a game trail; he stated, however, that it was too large for a game trail. Ice action or vandalism could both be causes of the gouge. Except at the gouge, the low areas are probably caused by settlement.

(3) North Embankment. The brush and trees on this embankment are undesirable. Because of the brush, the inspection cannot be considered definitive. The variation in slopes from the reported design values is not considered to be significant and is not considered a deficiency. Because of the swamp downstream, it would be impossible to monitor seepage at the toe of the embankment. It is believed that the low areas at the top of the embankment were mainly caused by snow-plowing operations. Although they may have been partly caused by settlement.

(4) Appurtenant Structures. The spalling in the main spillway concrete is probably caused by long term exposure to the elements.

b. Design and Construction Data. There is no record of design data or stability analysis. Analysis of the embankment stability is beyond the scope of this study. Also, sufficient data on the engineering properties of the embankment material would have to be acquired before the analysis could be performed. There is no evidence of previous stability problems having occurred on the embankment, except as noted below.

c. Operating Records. No formal records of operation were reviewed. According to the Owner, no stability problems have occurred over the operational history of the dam since 1927.

d. Postconstruction Changes. As noted herein, very little information was available for the spillway and embankment modifications made in 1927. The reported North Embankment settlement of about 1.5 feet immediately after construction is excessive for a 7-foot high embankment. If it occurred recently, it would be cause for concern. However, the modifications were made sufficiently long ago that any problems should be apparent by now.

e. Seismic Stability. Marshwood Dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone has adequate factors of safety under static loading conditions, it can be assumed safe for any expected earthquake loading. However, since there are no formal static stability analyses, and since there is the potential of earthquake forces moving or cracking the masonry core-wall, the theoretical seismic stability of Marshwood Dam is not known.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety.

(1) Based on the visual inspection, available records, calculations, and past operational performance, Marshwood Dam is judged to be in fair condition. The existing spillway will pass 65 percent of the PMF without overtopping of the dam. The spillway capacity is rated as inadequate.

If the embankment were raised to its design elevation, the spillway would be able to pass 80 percent of the PMF. The spillway capacity would still be rated as inadequate.

These spillway capacity ratings are dependent on the implementation of some of the recommendations hereinafter.

(2) There is no formal stability analysis available for Marshwood Dam. However, there is no evidence of problems presently threatening the stability of the embankment.

(3) The visual inspection resulted in some deficiencies, which are summarized below for the various features.

Feature and Location	Observed Deficiencies
South Embankment	
Top	Low areas, brush
Slopes and toes	Trees and brush
Adjacent to valve house	Gouge
North Embankment	
Top	Low areas
Slopes	Trees and brush

Outlet Works	
Pipes	Pipes under pressure through embankment.
Access	Not available during higher spillway discharges
Main Spillway	
Approach	Dislodged riprap
Walls and baffle blocks	Spalling
Downstream channel	Dislodged wire mesh, brush
Auxiliary Spillway	
Approach and canal banks	trees and brush.
Reservoir Area	
Pipe in reservoir	May extend under pressure through the embankment.

b. Adequacy of Information. Although there is no evidence of serious stability problems on the embankment, the amount of brush on the embankment precluded a definitive visual inspection. The information on other features of the dam is adequate.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented immediately.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations by the Owner will be required.

7.2 Recommendations and Remedial Measures.

a. The following measures are recommended to be undertaken by the Owner, in approximate order of priority, immediately:

(1) Clear the auxiliary spillway banks and approach of trees and brush. The auxiliary spillway should then be surveyed to determine its existing bedslope and template. Take appropriate action as required.

(2) Remove brush and trees that are in the main spillway outlet channel and that are on or near the embankment. When the brush and trees are removed, the embankment should be inspected on a regular basis to check for wet areas or seepage. After the brush is removed, the embankments should be inspected in detail to determine if any deficiencies exist. Take appropriate action as required.

(3) Repair the gouge on the South Embankment.

(4) Raise the embankments to their design elevation.

(5) Repair the wire mesh in the main spillway outlet channel and the riprap in the approach channel.

(6) Repair the concrete in the stilling basin.

(7) Investigate the pipe in the reservoir and adequately plug it, if it extends through the embankment.

(8) Ensure that proper plugs are available for upstream closure facilities on the outlet works pipe.

(9) Undertake a study to determine the adequacy of the access to the outlet works during periods of high spillway discharge. Undertake remedial measures as required.

b. In addition, it is recommended that the Owner modify his operational procedures as follows:

(1) Develop a detailed emergency operation and warning system for Marshwood Dam and Dunmore No. 4 Dam. A similar recommendation is being made for Dunmore No. 3 Dam.

(2) Modify snowplowing operations to avoid removing material from the top of the dam.

(3) Provide round-the-clock surveillance of Marshwood Dam during periods of unusually heavy rains.

(4) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88

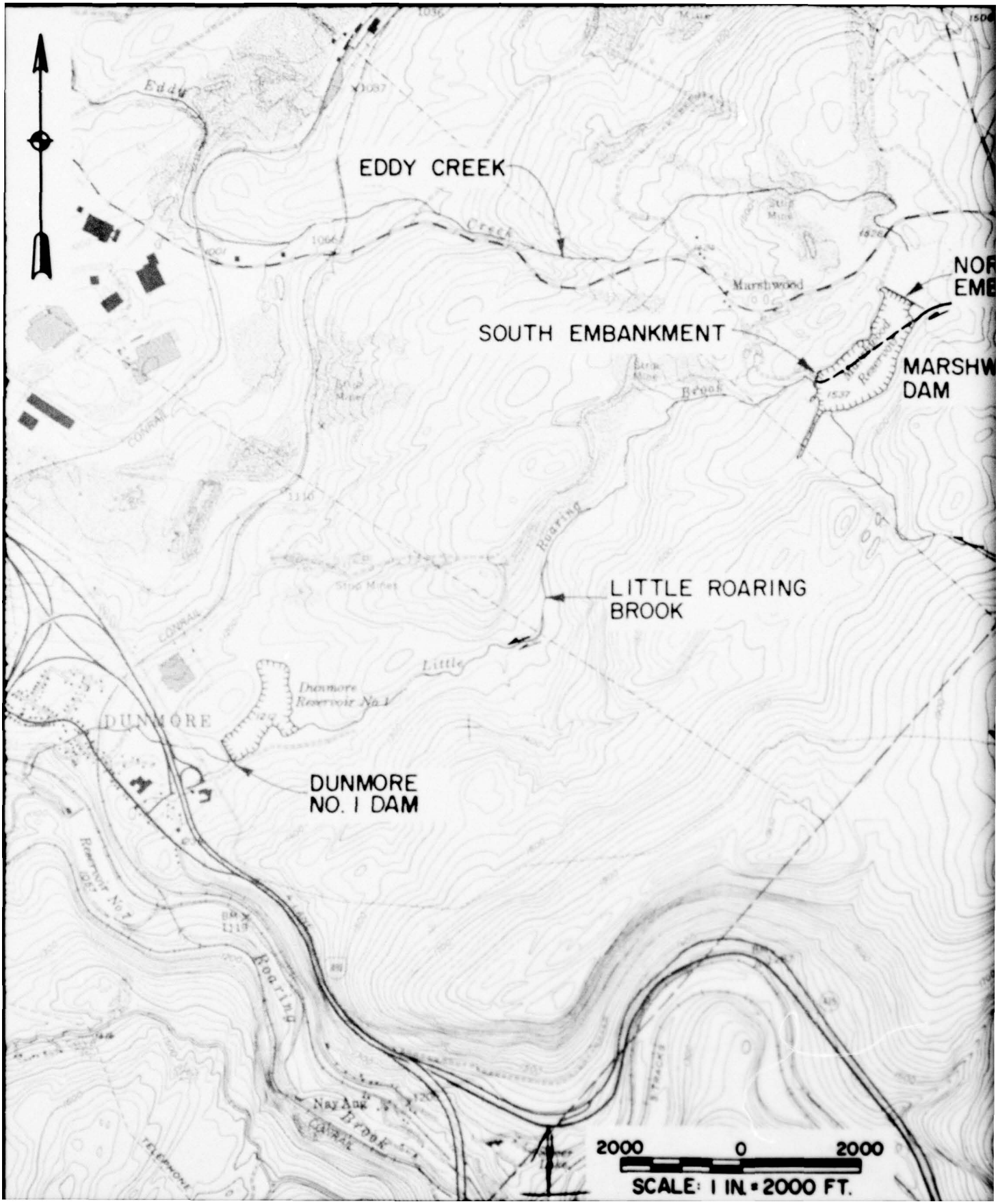
PENNSYLVANIA GAS AND WATER COMPANY

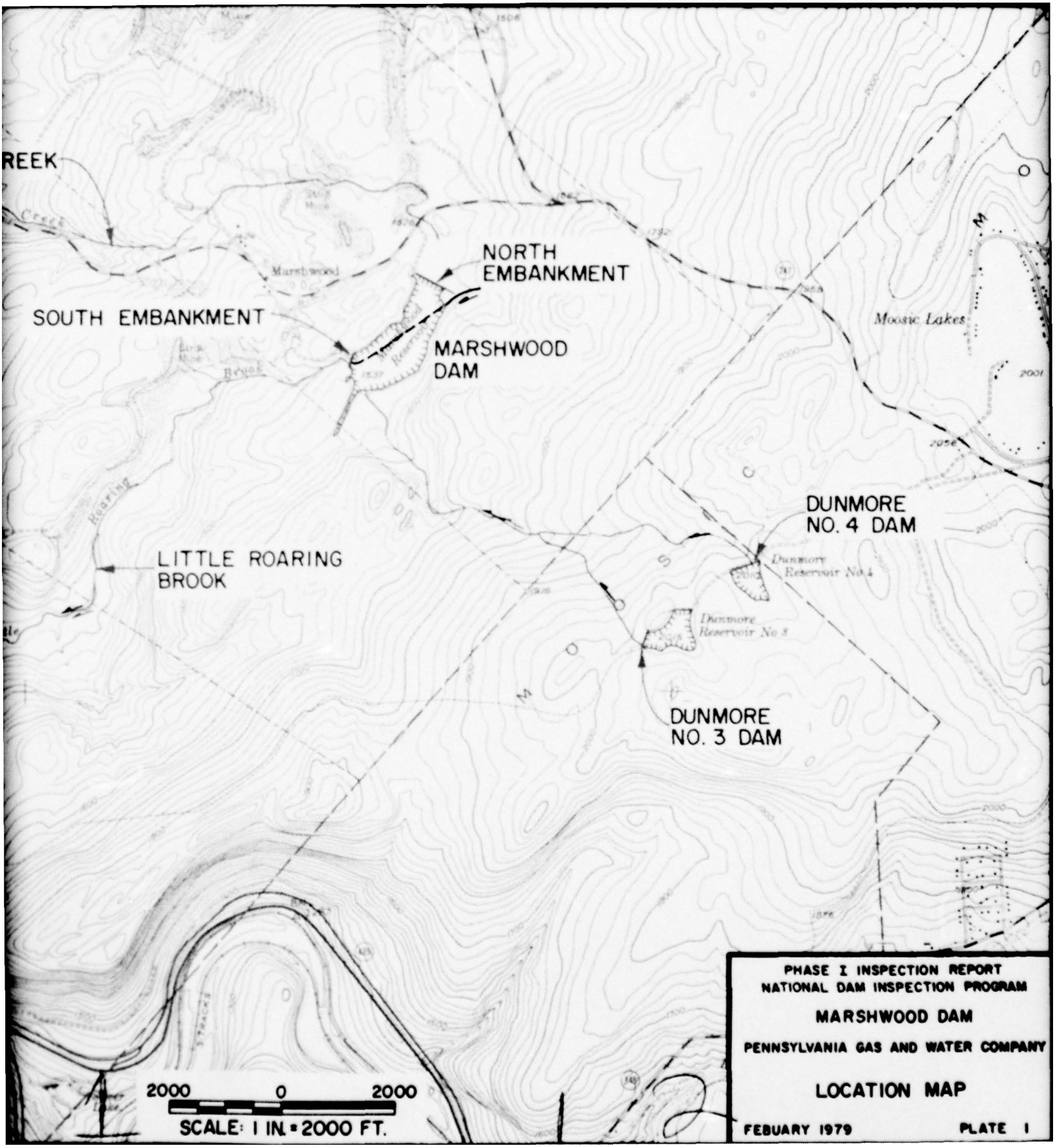
PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

PLATES


EDDY CREEK
SOUTH EMBANKMENT
NOR
EME
MARSHW
DAM
LITTLE ROARING
BROOK
DUNMORE
NO. 1 DAM
Eddy
Creek
Marshwood
Brook
Roaring
Little
Dunmore
Reservoir No. 1
DUNMORE
Reservoir No. 2
Roaring
Brook
Nay Aug
Brook
CONRAIL
TELEPHONE
2000 0 2000
SCALE: 1 IN. = 2000 FT.



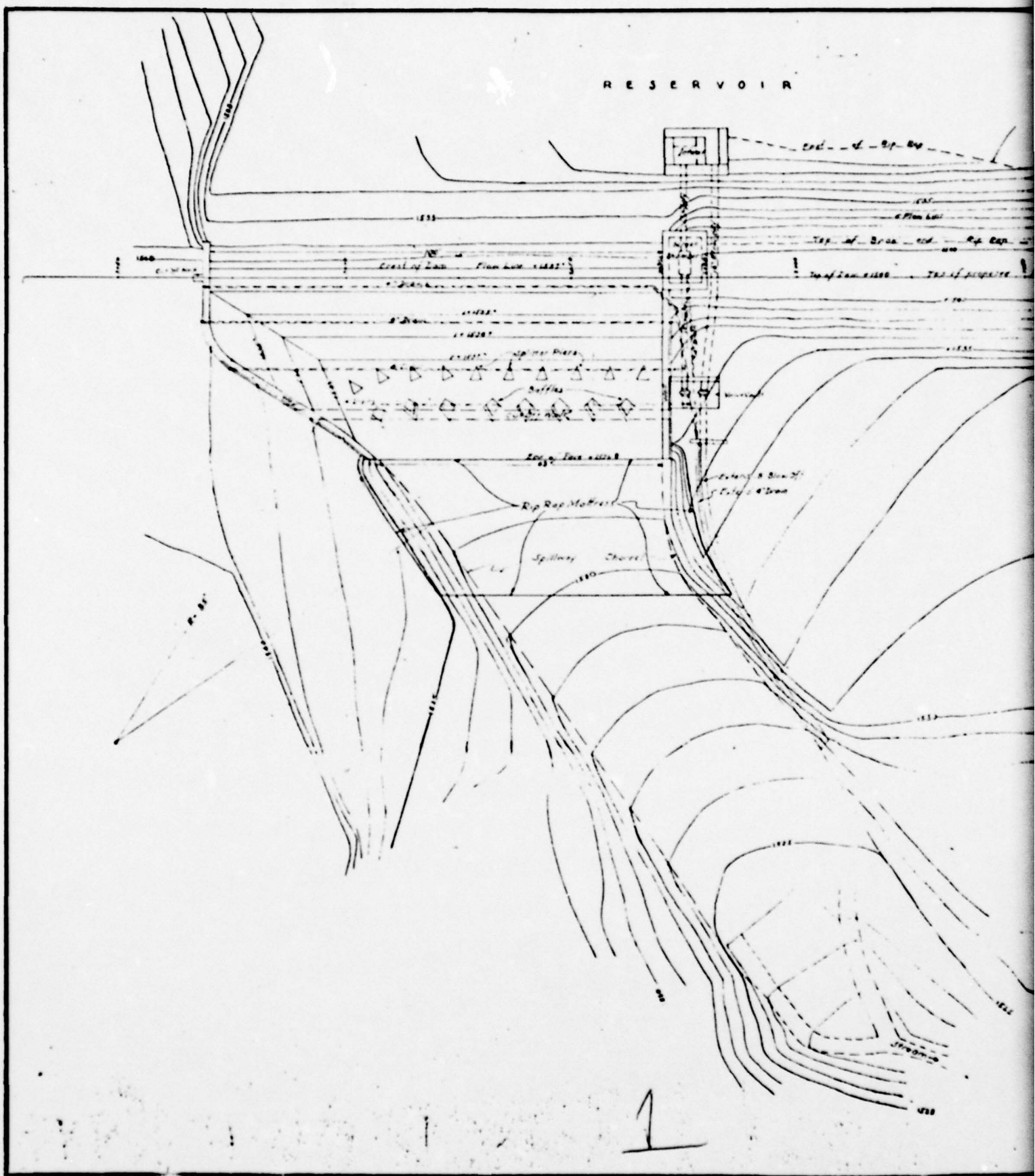
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MARSHWOOD DAM

PENNSYLVANIA GAS AND WATER COMPANY

LOCATION MAP

FEBUARY 1979 PLATE 1


RESERVOIR
Baffles
Rip Rap Material
Spillway Chute

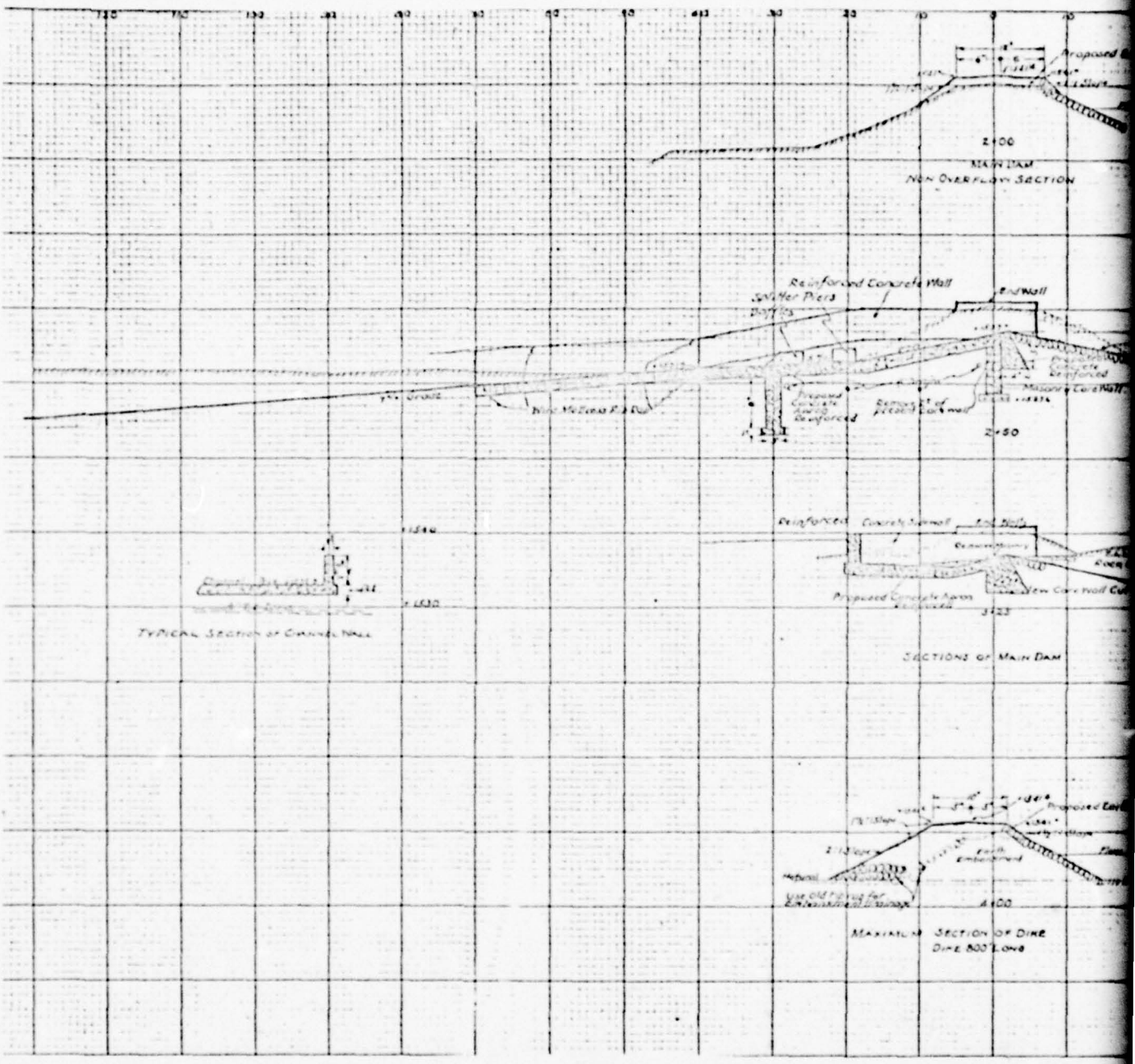
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MARSHWOOD DAM

PENNSYLVANIA GAS AND WATER COMPANY

SOUTH EMBANKMENT
AND SPILLWAY

FEBUARY 1979 PLATE 2



SCRANTON SPRING BROOK WATER SERVICE CO.
SCRANTON, PENNA.

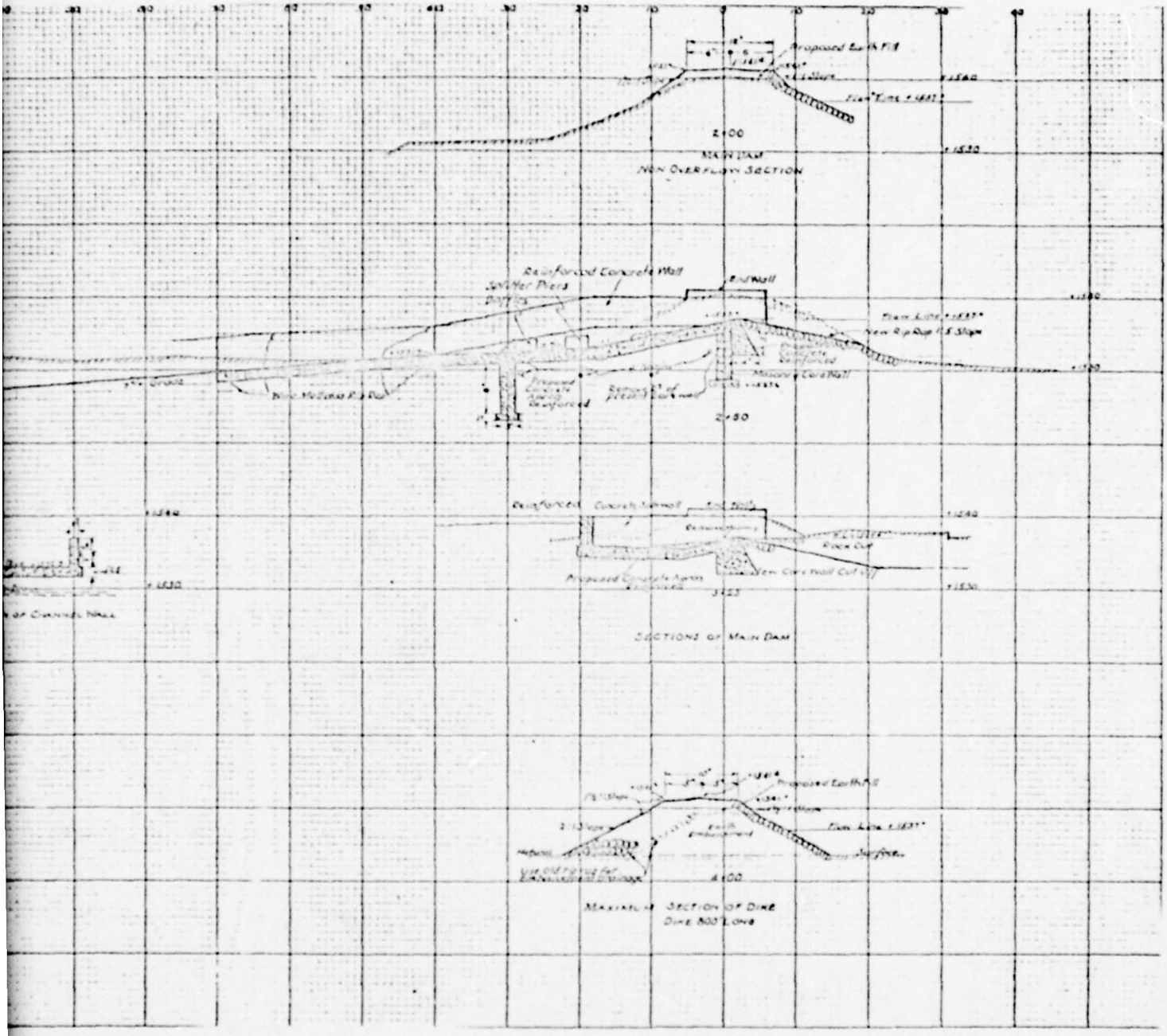
MARSHWOOD RESERVOIR
SECTIONS OF PROPOSED SPILLWAY
AND EARTH EMBANKMENTS
OLYPHANT BORO., LACKA. CO., PA.

DRAWN A.C.R.
TRACED BY W.R.B.
DATE June 28, 1941
SCALES 1 inch = 10 feet

H.A. Vicker

00-35365

1



SCRANTON SPRING BROOK WATER SERVICE CO
SCRANTON, PENNA.

MARSHWOOD RESERVOIR
SECTIONS OF PROPOSED SPILLWAY
AND EARTH EMBANKMENTS
OLYPHANT BORO., LACKA. CO., PA.

DESIGNED BY W.R.B.
DATE June 30, 1941
SCALE 1 inch = 10 feet

00-35.365

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

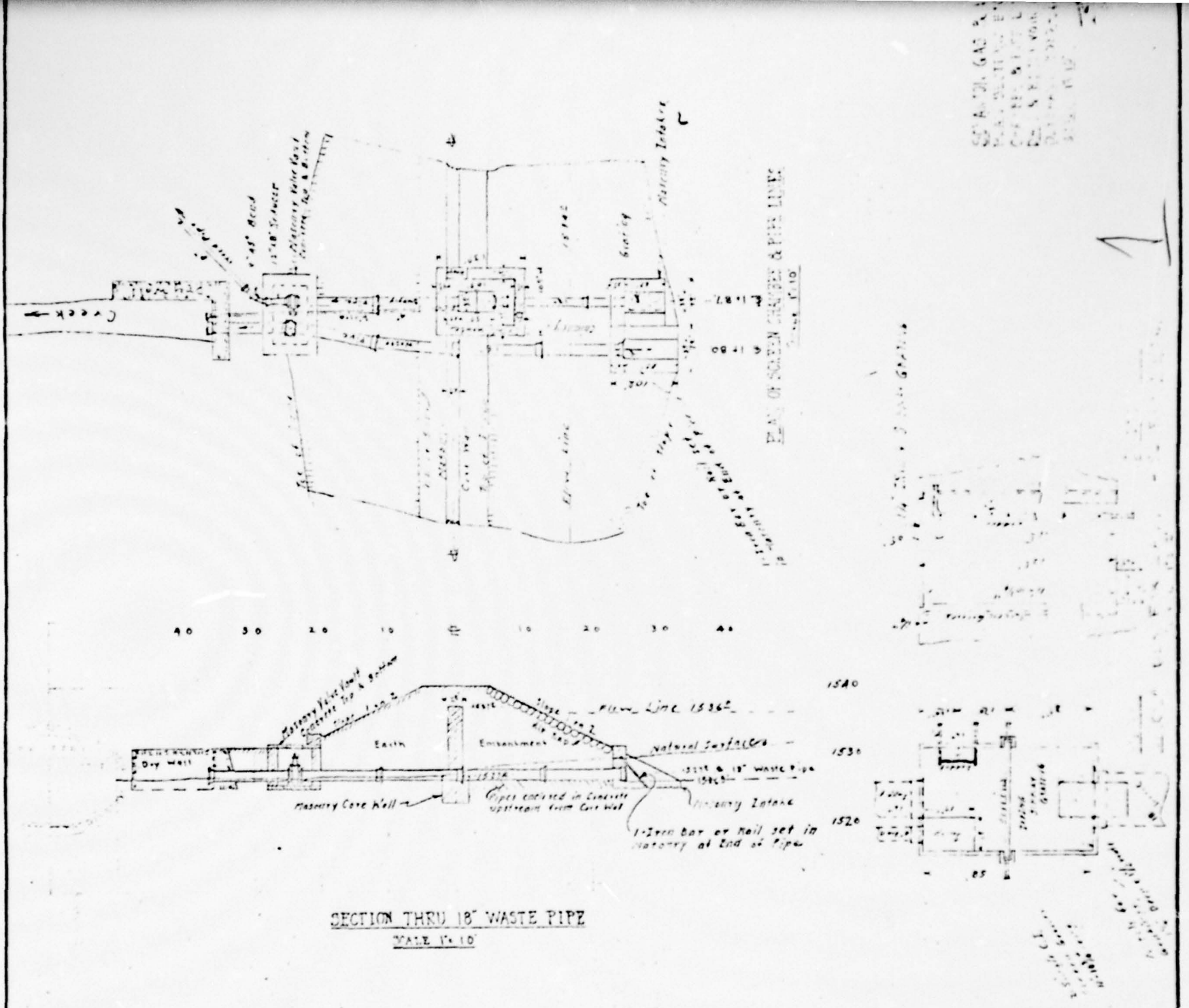
MARSHWOOD DAM

PENNSYLVANIA GAS AND WATER COMPANY

TYPICAL SECTIONS

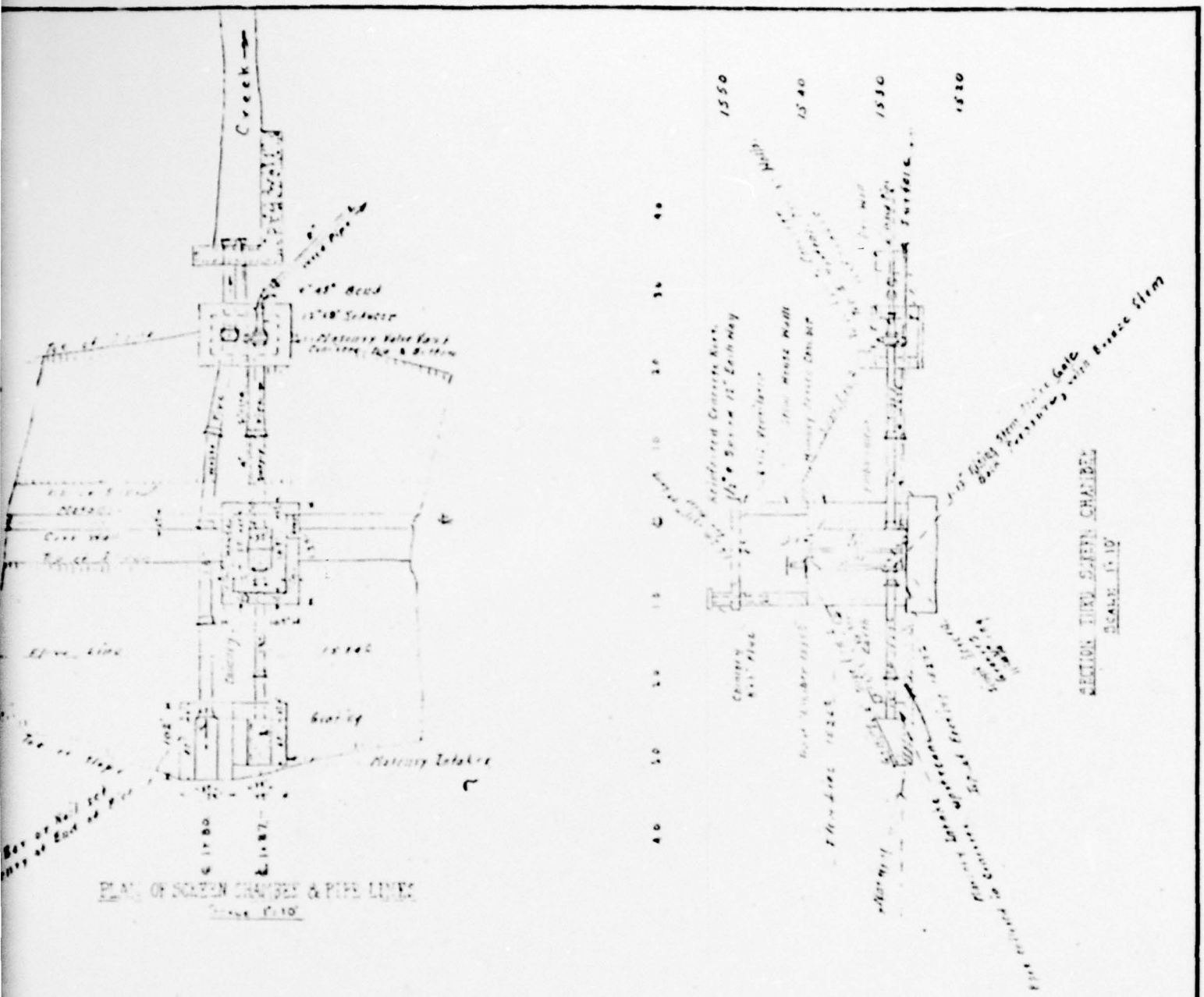
FEBUARY 1979

PLATE 3



SECTION THRU 18" WASTE PIPE

SCALE 1" = 10'



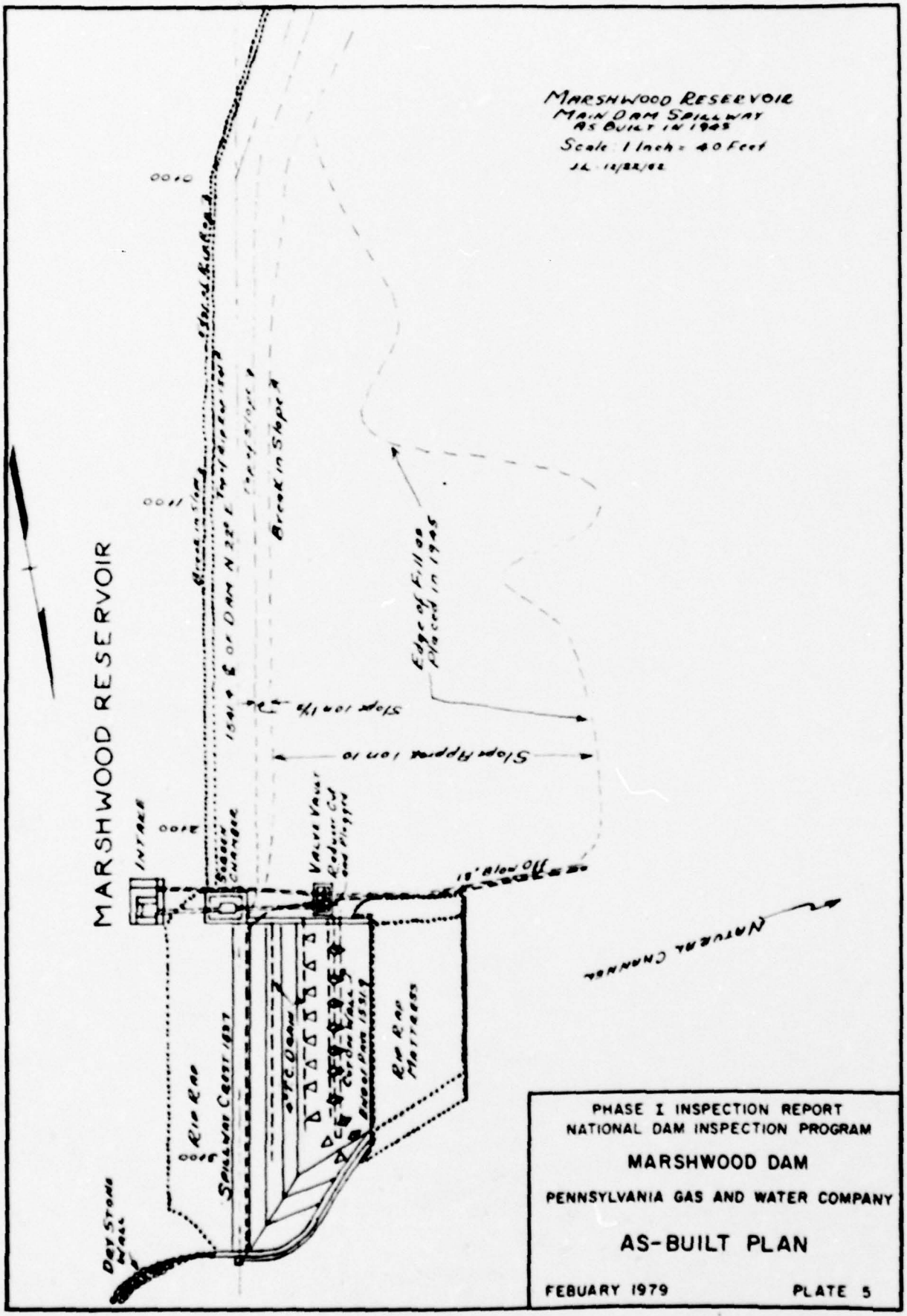
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MARSHWOOD DAM

PENNSYLVANIA GAS AND WATER COMPANY

OUTLET WORKS

FEBUARY 1979 PLATE 4



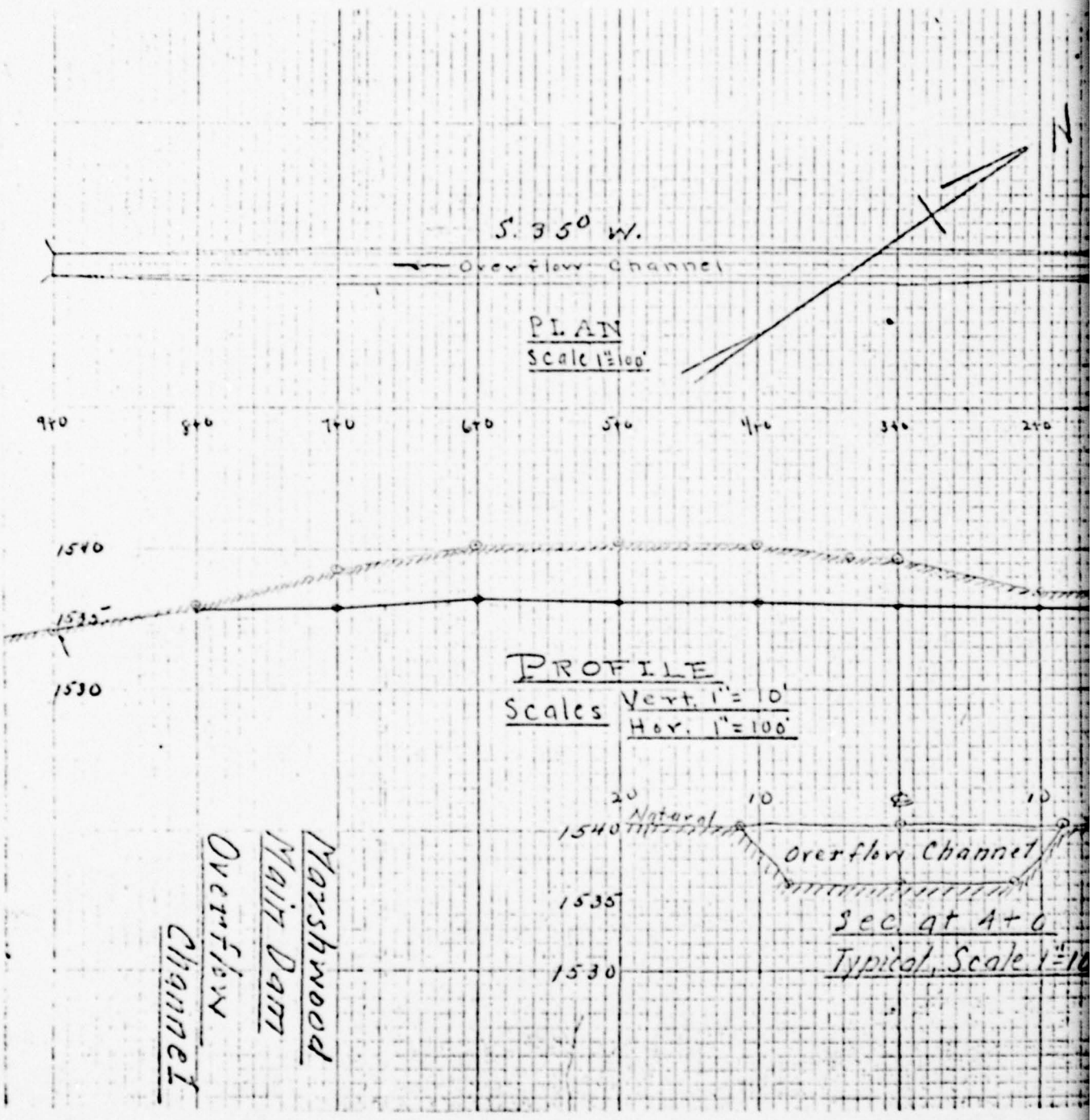
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MARSHWOOD DAM

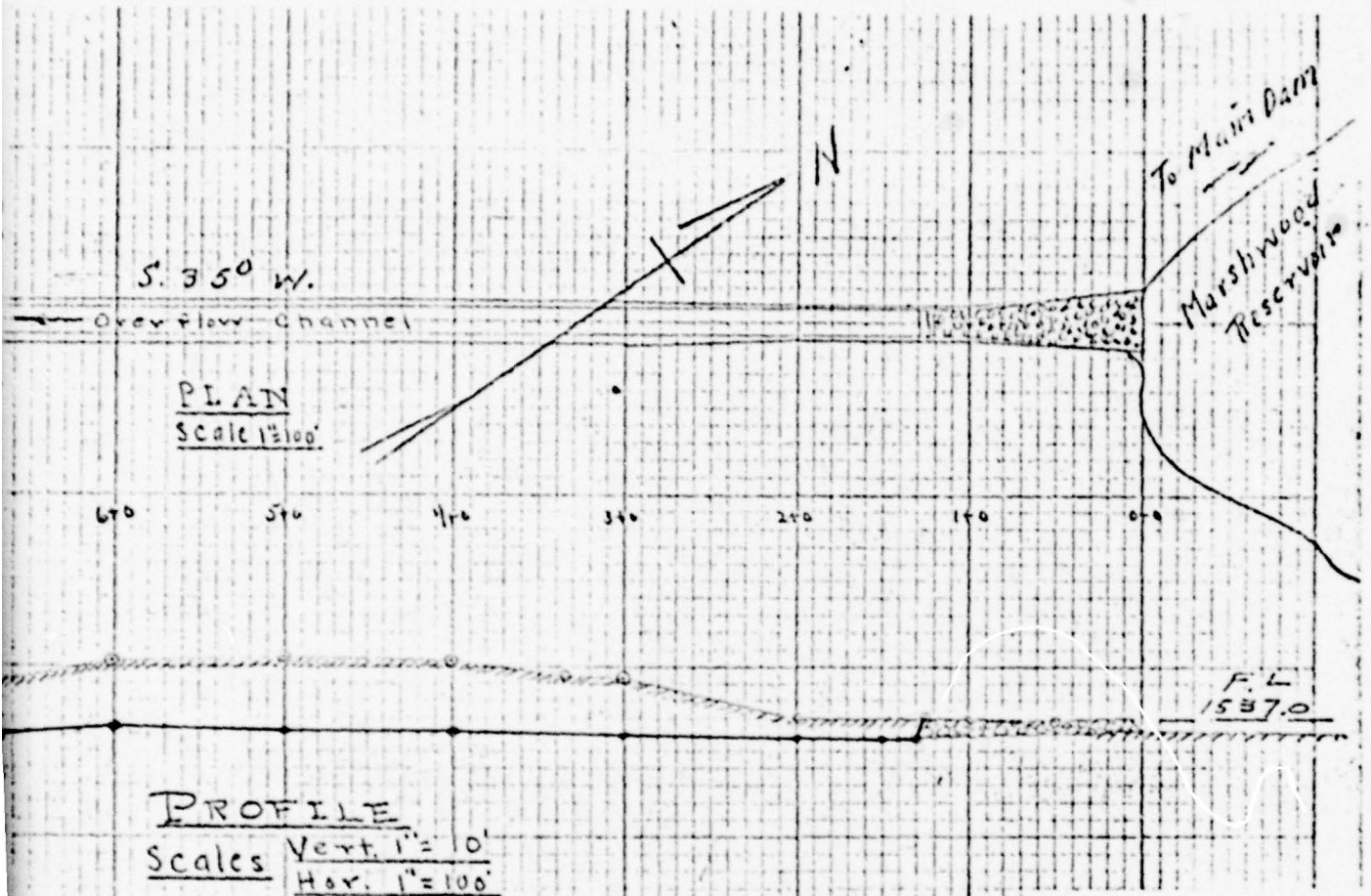
PENNSYLVANIA GAS AND WATER COMPANY

AS-BUILT PLAN

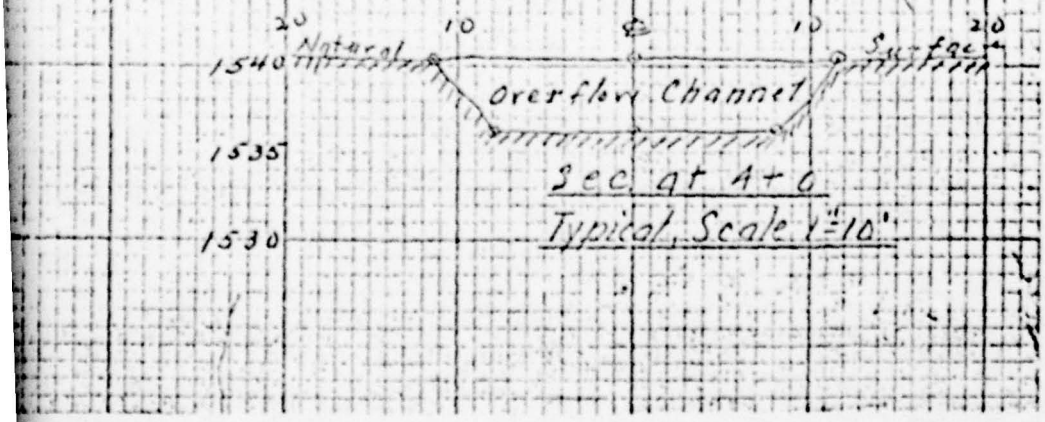
FEBUARY 1979 PLATE 5


N
S. 35° W.
Overflow Channel
PLAN
Scale 1"=100'
9+0
8+0
7+0
6+0
5+0
4+0
3+0
2+0
1540
1535
1530
PROFILE
Scales Vert. 1"= 10'
Hor. 1"=100'
20
10
10
Natural
1540
Overflow Channel
1535
1530
Sec at 4+0
Typical, Scale 1"=10
Marshwood
Main Dam
Overflow
Channel

1



PROFILE
Scales Vert. 1"= 10'
Hor. 1"=100'



Sec at 4+0
Typical, Scale 1"=10'

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
MARSHWOOD DAM
PENNSYLVANIA GAS AND WATER COMPANY
AUXILIARY SPILLWAY
FEBUARY 1979 PLATE 6

1

12

SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: MARSHWOOD

NDI ID NO.: DA-00365 DER ID NO.: 35-8

Sheet 1 of 4

I-41

ITEM	REMARKS
AS-BUILT DRAWINGS	DESIGN DRAWINGS ONLY
REGIONAL VICINITY MAP	SEE PLATE 1
CONSTRUCTION HISTORY	BUILT 1926. AUXILIARY SPILLWAY ON NORTH EMBANKMENT REMOVED IN 1928 AND CHANNEL AT WEST END ADDED. 1945 - CHANNEL AT WEST END FILLED AND SPILLWAY AT WEST END OF MAIN EMBANKMENT ADDED.
TYPICAL SECTIONS OF DAM	SEE PLATES 2 AND 3
OUTLETS: Plan Details Constraints Discharge Ratings	PLANS AND DETAILS AVAILABLE. NO RATINGS AVAILABLE.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	"Report on the Application by the Owners by the Pennsylvania Water Supply Commission - 1926
GEOLOGY REPORTS	NONE
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	Informal computations in PennDER files for hydraulics and hydrology. No other computations.
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	NONE
POSTCONSTRUCTION SURVEYS OF DAM	NONE

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	NO INFORMATION AVAILABLE.
MONITORING SYSTEMS	NONE
MODIFICATIONS	SEE CONSTRUCTION HISTORY.
HIGH POOL RECORDS	NONE
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	NONE
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	OVERTOPPED BY SMALL AMOUNT ABOUT 1932

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	NONE
SPILLWAY: Plan Sections Details	PLANS SECTIONS AND DETAILS AVAILABLE.
OPERATING EQUIPMENT: Plans Details	SEE "OUTLETS"
PREVIOUS INSPECTIONS Dates Deficiencies	1927 - LOW AREA NEAR GATE HOUSE. NORTH EMBANKMENT SETTLED 3"-4" ABOVE WATER SURFACE. SPILLWAY AT LEFT END OF SECONDARY EMBANKMENT. 1928 - NOTES NORTH EMBANKMENT WAS RAISED. TOE OF NORTH EMBANKMENT SWAMPY. 1930 - SPILLWAY OBSTRUCTED BY LOOSE STONE AND GRASS. 1933 - EROSION ON UPSTREAM FACE. NOTES PREVIOUS OVERTOPPING. 1934 - SLIGHT LEAK AT OUTLET.
	1941 - SWAMPY AND OVERGROWN AT TOE OF NORTH EMBANKMENT. 1953 - NO DEFICIENCIES. 1957 - POOR MAINTENANCE.

4-4

SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: MARSHWOOD County: LACKAWANNA State: PENNSYLVANIA

NDI ID No.: PA-00365 DER ID No.: 35-88

Type of Dam: EARTHFILL WITH MASONRY CORE WALL Hazard Category: HIGH

Date(s) Inspection: 25 OCTOBER 1978 Weather: CLEAR Temperature: 45°F±

SOIL CONDITIONS: MOIST MANY LEAVES COVERING GROUND

POOL BEING DRAWN DOWN.

Pool Elevation at Time of Inspection: 1535.10 msl/Tailwater at Time of Inspection: FLOW AT OUTLET msl
LOW - NOT MEASURED.

Inspection Personnel:

D. WOLF (GFCC)

D. EBERSOLE (GFCC)

J. BORDNAR (PGW)

A. WHITMAN (GFCC) Recorder

B-2

SOUTH
EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NONE	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NONE	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	FOR A 10' LENGTH NEAR VALVE HOUSE THERE IS A GOUGE. TOPWIDTH IS 50% OF NORMAL HERE.	EMBANKMENT IS SANDY SILT.
CREST ALIGNMENT: Vertical Horizontal	SEE SURVEY DATA SHEETS FOLLOWING INSPECTION FORMS.	
RIPRAP FAILURES	SEE SLOUGHING. ALSO 2 AREAS WITH GRASS ERODED.	

SOUTH
EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	NONE	THE LEFT ABUTMENT IS INDISTINCT.
ANY NOTICEABLE SEEPAGE	NONE	
STAFF GAGE AND RECORDER	NONE	
DRAINS	NONE	
BRUSH	THE ENTIRE EMBANKMENT IS COVERED WITH HEAVY BRUSH AND SMALL TREES.	

NORTH
EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	NONE	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NONE	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	SOIL PUSHED ONTO EMBANKMENT SLOPES.	PROBABLE SNOWPLOW OPERATIONS.
CREST ALIGNMENT: Vertical Horizontal	SEE SURVEY DATA ON SHEETS FOLLOWING INSPECTION FORM	
RIPRAP FAILURES	NONE	

B-4

NORTH
EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	NONE - STREAM FLOWS INTO RESERVOIR AT EAST END. THIS AREA APPEARS LOW.	
ANY NOTICEABLE SEEPAGE	ENTIRE TOE IS SWAMPY.	AREA AT TOE IS A SWAMP.
STAFF GAGE AND RECORDER	NONE	
DRAINS	NONE	
BRUSH	ENTIRE EMBANKMENT EXCEPT TOP IS COVERED WITH BRUSH.	

B-5

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	CIP	
INTAKE STRUCTURE	SUBMERGED	
OUTLET STRUCTURE	DRY MASONRY WALL FOR 18" dia CIP AND 6"I DRAIN.	
OUTLET CHANNEL	CLEAR AND ADEQUATE	
EMERGENCY GATE	PIPE FLOWING 50% FULL ON DAY OF INSPECTION.	

UNGATED SPILLWAY (MAIN)

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	AGGREGATE EXPOSED	BAD SPALLING ON SOME BAFFLE BLOCKS AND ON WALL IN 3 AREAS.
APPROACH CHANNEL	RIPRAPPED 1V ON 5H SLOPE - SOME STONES MISSING NEAR WEIR	
DISCHARGE CHANNEL	WIRE MESH OVER STONE RUSTED AND ROLLED UP. BRUSH IN CHANNEL BELOW.	
BRIDGE AND PIERS	NONE	

CANAL
~~GATED~~ SPILLWAY (AUXILIARY)

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	POORLY DEFINED AND MAINTAINED. TREES UP TO 2" d.A. AND BRUSH.	
DISCHARGE CHANNEL	BOTTOM GENERALLY CLEAR. BANKS ARE COVERED WITH BRUSH.	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE	
OBSERVATION WELLS	NONE	
WEIRS	NONE	
PIEZOMETERS	NONE	
OTHER	NONE	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	1V on 6H ±	
SEDIMENTATION	NO OBSERVED OR REPORTED PROBLEMS.	PIPE IN RESERVOIR APPEARS TO EXTEND UNDER EMBANKMENT. OWNER DOES NOT KNOW USE OF PIPE.
WATERSHED DESCRIPTION	WOODED AND UNINHABITED	

81-10

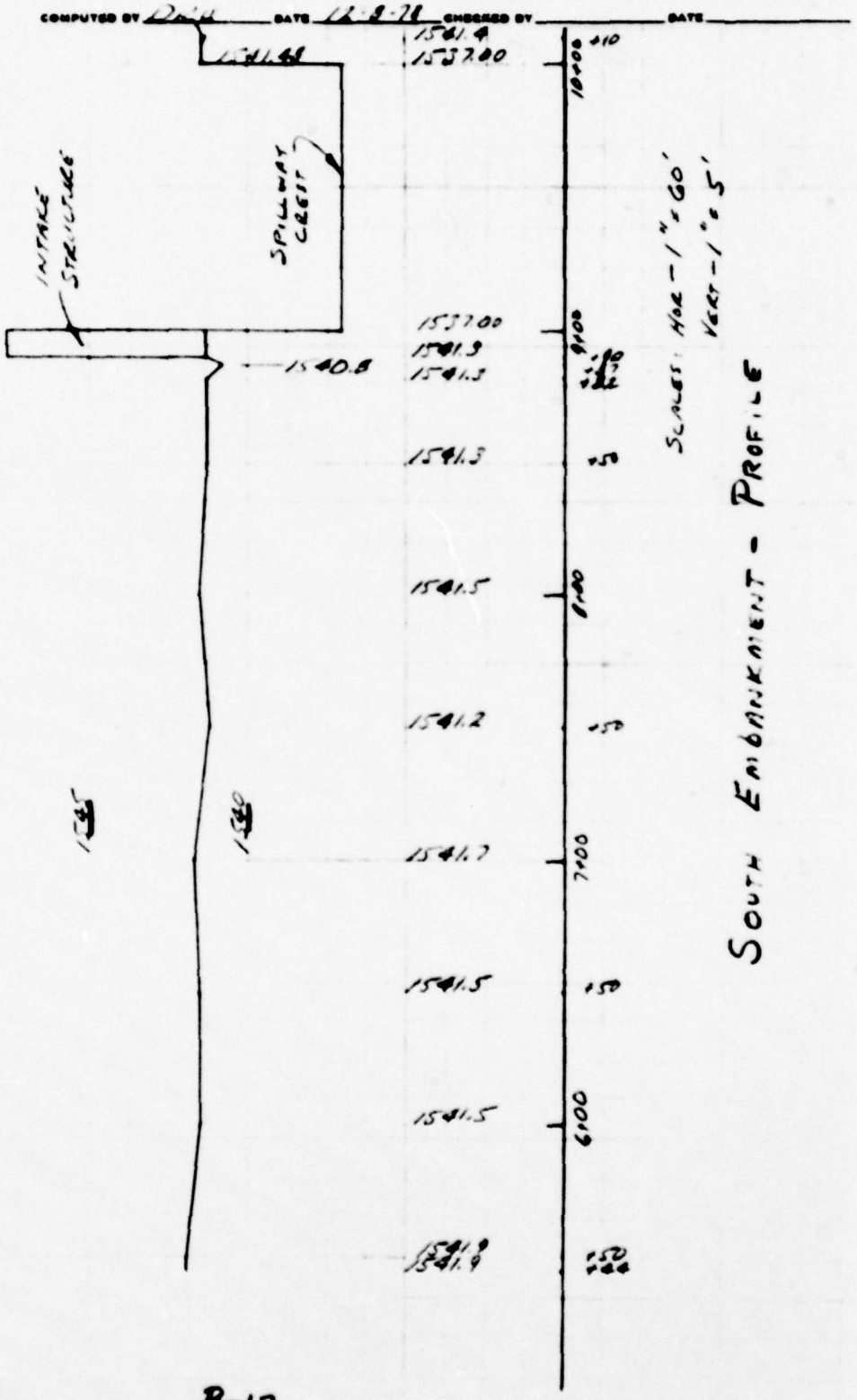
DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	CLEAR OF OBSTRUCTIONS	
SLOPES	STEEP	
APPROXIMATE NUMBER OF HOMES AND POPULATION	NONE	DUNMORE NO. 1 DAM DOWNSTREAM.

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

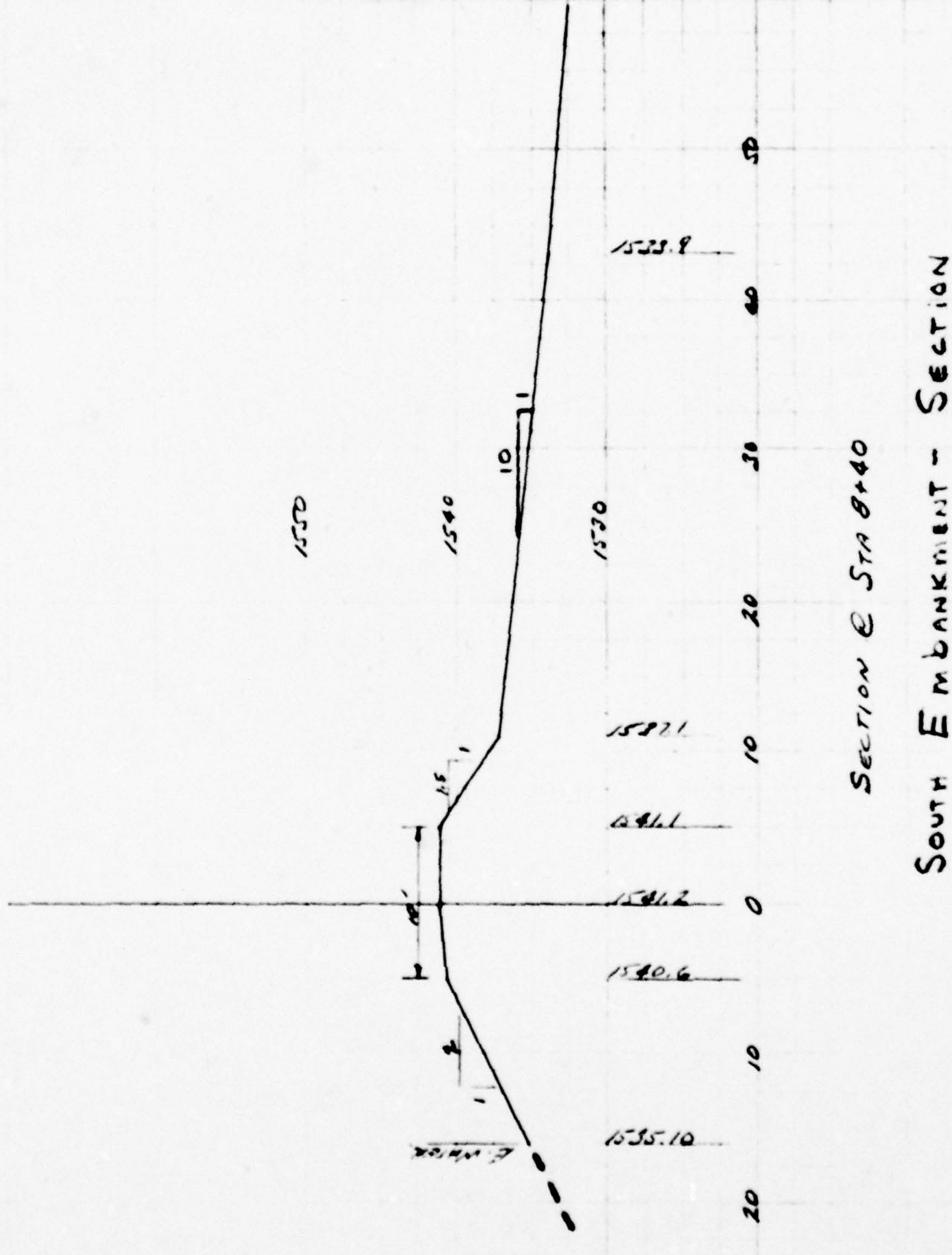
SUBJECT Mahantango Dam — FILE NO. 283-L
Profile - Main Embankment — SHEET NO. ___ OF ___ SHEETS
FOR
COMPUTED BY DAH — DATE 12-9-71 — CHECKED BY ___ — DATE ___



B-12

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

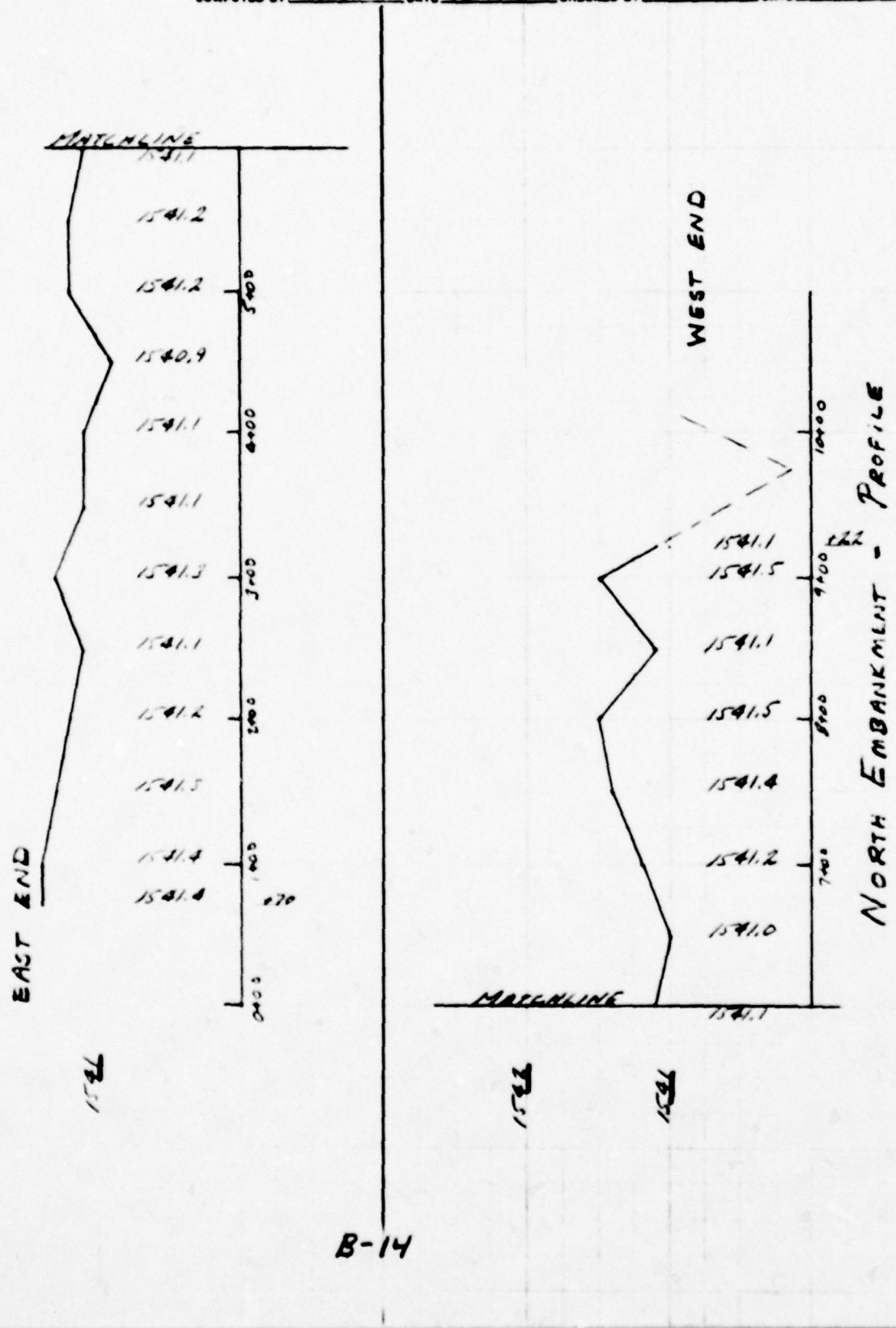
SUBJECT: Marshwood Dam — FILE NO. 2832
Section - Main Embankment — SHEET NO. ____ OF ____ SHEETS
FOR ____
COMPUTED BY: DKG — DATE: 12-8-78 — CHECKED BY: ____ DATE: ____



0019

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT Harrison Dam — FILE NO. 7832
Spillway - Dike Embankment — SHEET NO. ___ OF ___ SHEETS
FOR
COMPUTED BY DKG — DATE 12-8-78 — CHECKED BY ___ — DATE ___



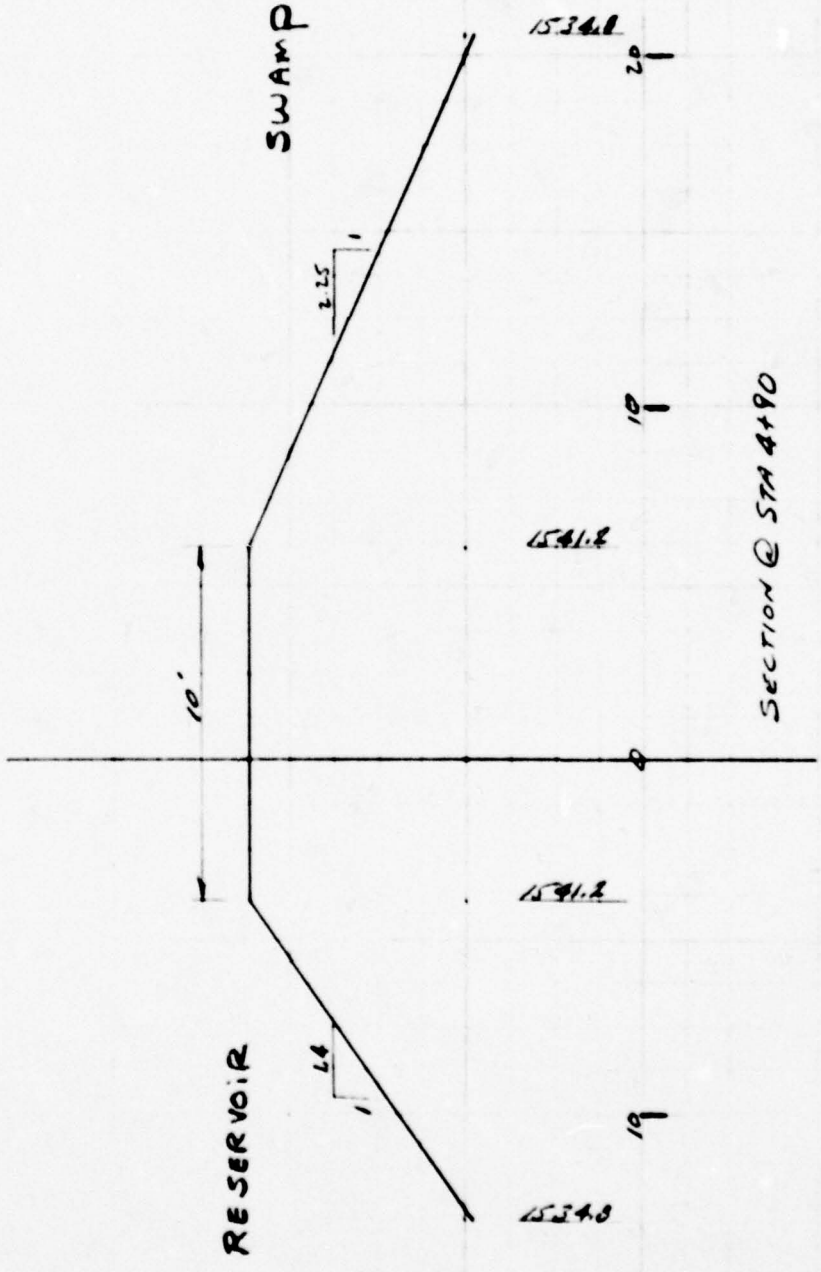
NORTH EMBANKMENT - PROFILE

B-14

0010

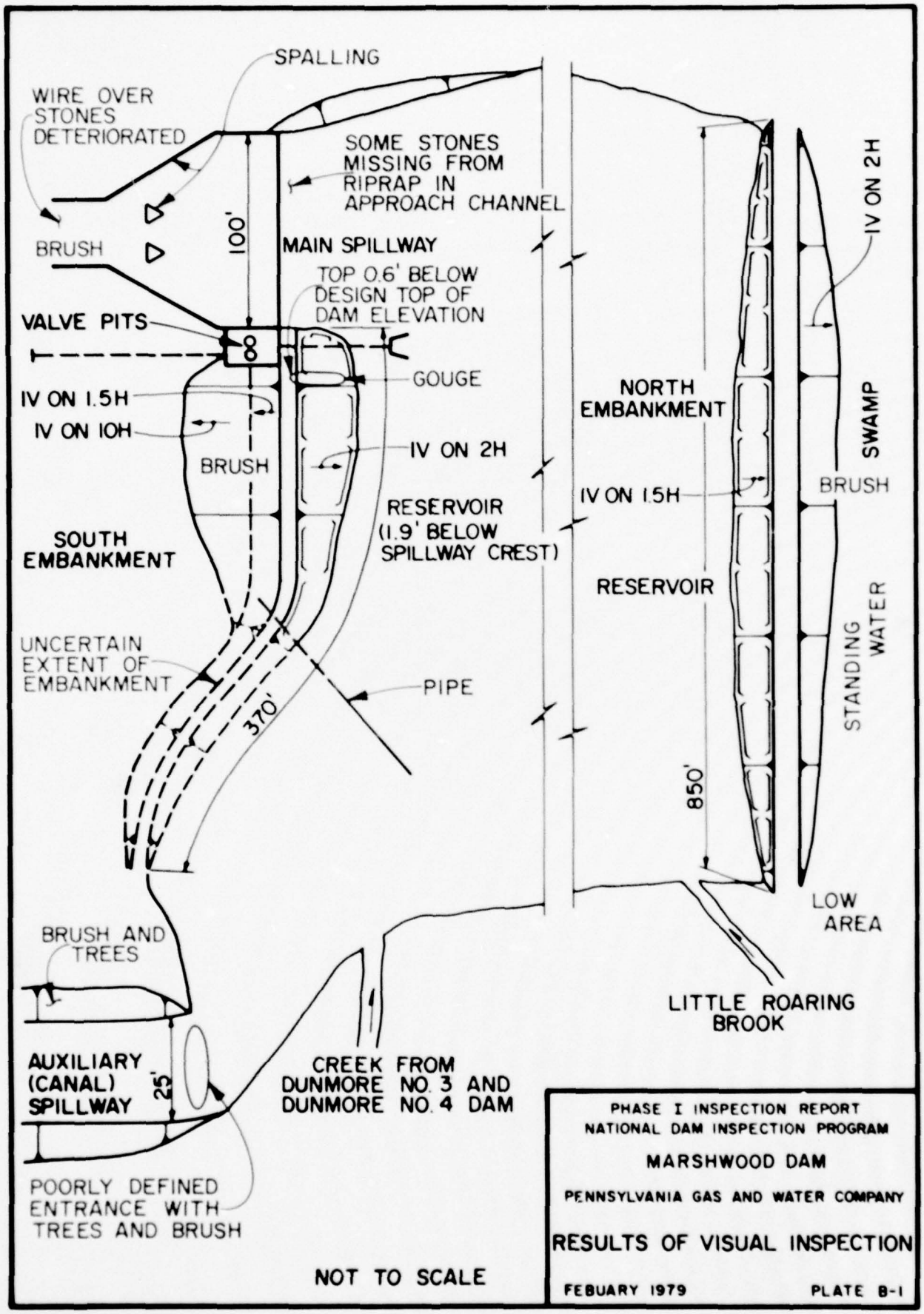
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT MARSHWOOD DAM FILE NO. 7882
SECTION - AUX EMBANKMENT SHEET NO. ___ OF ___ SHEETS
FOR
COMPUTED BY DRE DATE 12-8-78 CHECKED BY ___ DATE ___



B-15

8010



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MARSHWOOD DAM

PENNSYLVANIA GAS AND WATER COMPANY

RESULTS OF VISUAL INSPECTION

FEBUARY 1979 PLATE B-1

SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

APPENDIX C

HYDROLOGY AND HYDRAULICS

APPENDIX C

HYDROLOGY AND HYDRAULICS

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

APPENDIX C

SUSQUEHANNA River Basin

Name of Stream: LITTLE ROARING BROOK

Name of Dam: MARSHWOOD

NDS ID No.: PA-00365

DER ID No.: 35-08

Latitude: N 41° 25' 55" Longitude: W 75° 33' 45"

Top of Dam (~~low spot~~) Elevation: 1541.4

Streambed Elevation: 1527.0 Height of Dam: 14 ft

Reservoir Storage at Top of Dam Elevation: 286 acre-ft

Size Category: SMALL

Hazard Category: HIGH (see Section 5)

Spillway Design Flood: PMF because DUNMORE NO.1 DAM downstream has SDF or PMF

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
DUNMORE NO.4	1.5	14	55	} PARALLEL SYSTEMS
DUNMORE NO.3	1.3	13	78	

DOWNSTREAM DAMS

DUNMORE NO.1	2.2	47	609	INTERMEDIATE HIGH HAZARD

SUSQUEHANNA River Basin

Name of Stream: LITTLE ROARING BROOK

Name of Dam: MARSHWOOD

NDS ID No.: PA-00365

DER ID No.: 35-88

Latitude: N 41° 25' 55" Longitude: W 75° 33' 45"

DETERMINATION OF PMF RAINFALL

For Area A

which consists of Subareas A1 of 0.23 sq. mile

A2 0.14

A3 1.27

Total Drainage Area 1.64 sq. mile

PMF Rainfall Index = 22.15 in., 24 hr., 200 sq. mile

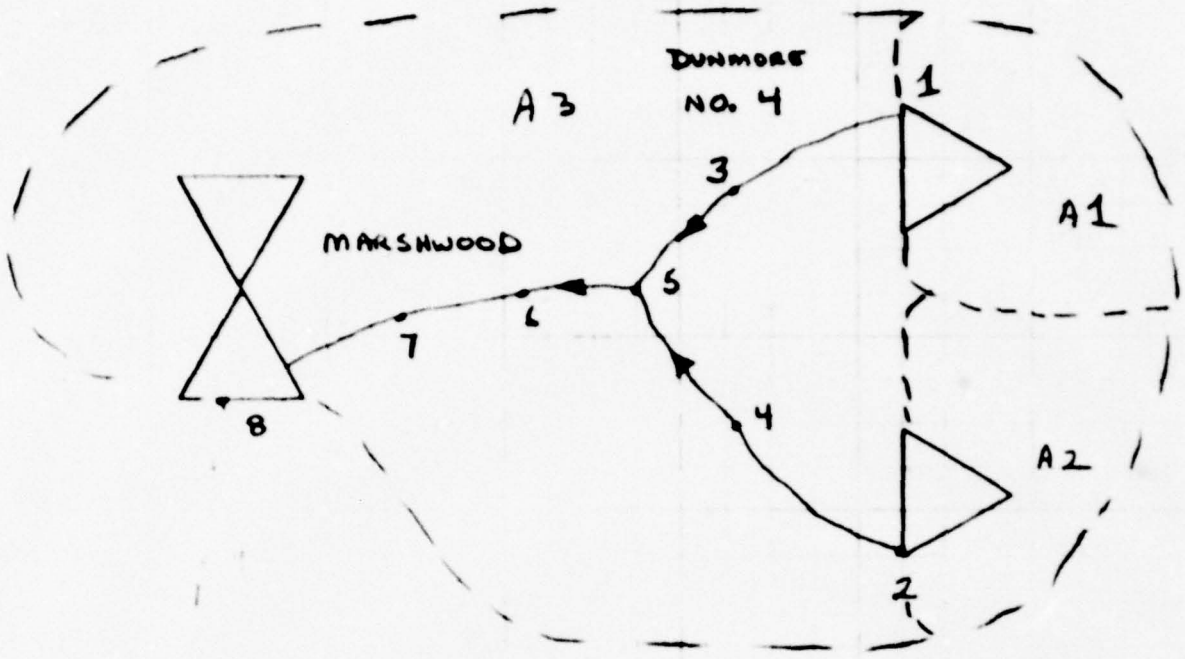
	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone	N/A	
Geographic Adjustment Factor	97%	1.0
Revised Index Rainfall	21.5	

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	110
12 hours	127
24 hours	136
48 hours	142
72 hours	145
96 hours	N/A

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____
SHEET NO. _____ OF _____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____



DUNMORE NO. 1 DAM
DOWNSTREAM
NOT INCLUDED
IN ANALYSIS

SKETCH
OF
SYSTEM

0010

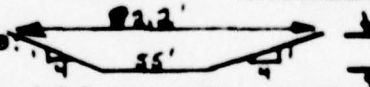
Data for Dam at Outlet of Subarea A-1
(see Sketch on Sheet C-4)

Name of Dam: DUNMORE NO. 4 Sheet 1 of

Height: 14 FEET (Approx.) (existing) FROM DER RECORDS

Spillway Data: SEE NEXT SHEET. OUTLET WORKS ASSUMED NEGLIGIBLE FOR FLOOD FLOWS	Existing Conditions	Design Conditions
Top of Dam Elevation	2016.5	2017.1
Spillway Crest Elevation	2013.7	2013.7
Spillway Head Available (ft)	2.8	3.4
Type Spillway	TRAPEZOIDAL	
"C" Value - Spillway	2.7	2.7
Crest Length - Spillway (ft)	55	55
Spillway Peak Discharge (cfs)	888	1239 *
Auxiliary Spillway Crest Elevation	NONE	NONE
Auxiliary Spillway Head Available (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spillway		
Crest Length - Auxiliary Spillway (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)	888	1239

Spillway ~~Rating Curve~~ SECTION



Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
2013.7	0	N/A	0
2014.4	98		98
2015.1	282		282
2015.7	528		528
2016.4	830		830
~~2017.0~~	~~1182~~		~~1182~~
~~2017.7~~	~~1589~~		~~1589~~

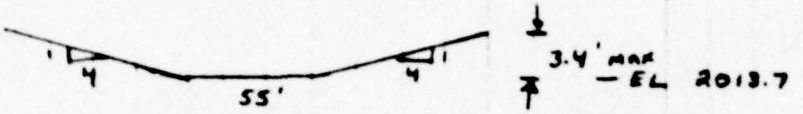
* 1040 CFS IN A-- REPORT 3/22/46
THOS H. WIGGIN
CONSULTING ENGINEER

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____
SHEET NO. ____ OF ____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

DUNMORE NO 4 SPILLWAY RATING CURVE

CRITICAL DEPTH ADJUSTED → $Q = \frac{2.7}{3.1}\sqrt[2]{\frac{A^3 g}{T}}$



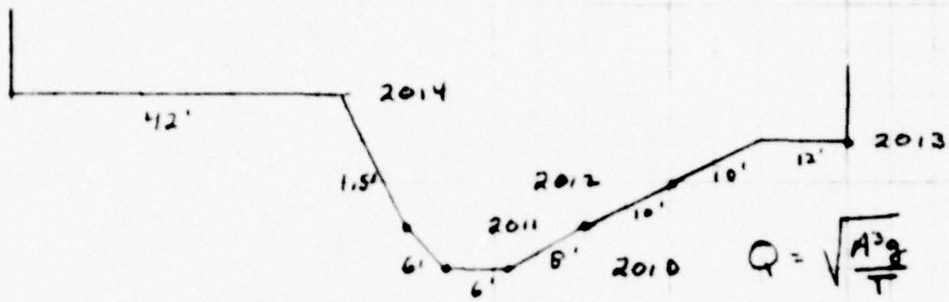
depth	Area	Topwidth	Q	V	hv	EGL
0.5	28.5	59	98	3.43	.18	2014.38
1	59	63	202	4.78	.36	2015.06
1.5	91.5	67	528	5.77	.52	2015.72
2	126	71	829	6.58	.67	2016.37
2.5	162.5	75	1182	7.27	.82	2017.02
3.0	201	79	1584	7.88	.97	2017.67
3.4	233.24	82.2	1941	8.32	1.08	2018.18
4.0	282.56	82.2	2588	9.16	1.30	2019.00

0015

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT ______ FILE NO. ______
SHEET NO. ____ OF ____ SHEETS
FOR ______
COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

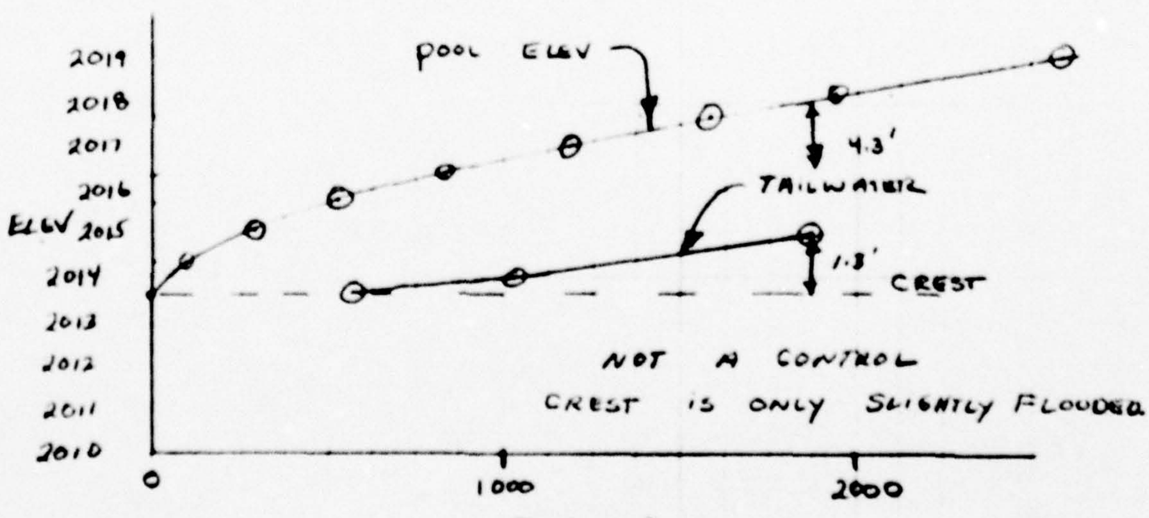
DUNMORE NO. 4
TAILWATER



$Q = \sqrt{\frac{A^3 g}{T}}$

FROM PLAN IN DUNMORE 3 FILE

d	A	T	Q	d + 2010 = W.S.
0	–	–	0	2010
1	13	20	59	2011
2	38.25	30.5	243	2012
3	74	41	564	2013
4	121.25	53.5	1035	2014
5	216.75	95.5	1852	2015
6	312.25	95.5	3203	2016



8819

Data for Dam at Outlet of Subarea A1

Name of Dam: Dunmore No.4 Sheet 3 of __

Storage Data:

Elevation	Area (acres)	Storage million gals	Storage acre-ft	Remarks
1998.4 = ELEVO*	0	0	0	
2013.7 = ELEV1	6 = A1	10	30.7 = S1	
2020	20.6			
**				

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at ~~Top of Dam~~ Normal Pool is 4 percent of watershed.

Remarks: _____

SUSQUEHANNA River Basin

Name of Stream: LITTLE ROARING BROOK

Name of Dam: MARSHWOOD

NDS ID No.: PA-00365

DER ID No.: 35-25

Latitude: N 41° 25' 55" Longitude: W 75° 33' 45"

Drainage Area: 1.64 sq. mile

Data for Subarea: A1 (see Sketch on Sheet C-4)

Name of Dam at Outlet of Subarea: DUNMORE NO.4

Drainage Area of Subarea: 0.23 sq. mile

Subarea Characteristics:

Assumed Losses: 1.0-inch initial abstraction + 0.05 in/hr

The following are measured from outlet of subarea to the point noted:

L = Length of Main Watercourse extended to the divide = .625 mile

L_{CA} = Length of Main Watercourse to the centroid = .283 mile

From NAB Data: AREA 11, PLATE E

Cp = 0.62

C_T = 1.5

$Tp = C_T \times (L \times L_{CA})^{0.3}$ = 0.89 (hrs)

Flow at Start of Storm = 1.5 cfs/sq. mile x Subarea D.A = 0.3 cfs

Computer Data:

QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

Remarks: _____

Data for Dam at Outlet of Subarea A-2
(see Sketch on Sheet C-4)

Name of Dam: DUNMORE NO. 3 Sheet 1 of __

Height: 13 FT (existing) OUTLET WORKS IGNORED FOR FLOODFLOWS

Spillway Data: FROM PHASE I REPORT FOR DUNMORE NO. 3 DAM

	Existing Conditions	Design Conditions
Top of Dam Elevation	2022.8	2023.3
Spillway Crest Elevation	2021.0	2021.0
Spillway Head Available (ft)	1.8	2.3
Type Spillway	OGEE-TYPE	TOP
"C" Value - Spillway	3.17*	3.17*
Crest Length - Spillway (ft)	48.0	48.0
Spillway Peak Discharge (cfs)	395	581*
Auxiliary Spillway Crest Elevation	NONE	NONE
Auxiliary Spillway Head Available (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spillway		
Crest Length - Auxiliary Spillway (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve:

* REPORT 3/22/46 TAOS H. WIGGIN CONSULTING ENGINEER USED 530 CFS.

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
2021	0	N/A	0
2021.8	100		100
2022.5	288		288
2023.2	538		538
2023.9	842		842
2024.4	1050		1050

Data for Dam at Outlet of Subarea A2

Name of Dam: DUNMORE NO.3 Sheet 3 of __

Storage Data:

Elevation		Area (acres)		Storage million gals	Storage acre-ft		Remarks
2002.6	= ELEVO*	0		0	0		
2021	= ELEV1	9	= A1	18	55.2	= S1	
2040	**	26.8					
	**						

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Top of Dam is 10 percent of watershed.

Remarks: _____

SUSQUEHANNA River Basin

Name of Stream: LITTLE ROARING BROOK

Name of Dam: MARSHWOOD

NDS ID No.: PA-00365

DER ID No.: 35-88

Latitude: N 41° 25' 55" Longitude: W 75° 33' 45"

Drainage Area: 1.64 sq. mile

Data for Subarea: A-2 (see Sketch on Sheet C-4)

Name of Dam at Outlet of Subarea: DUNMORE NO. 3

Drainage Area of Subarea: 0.14 sq. mile

Subarea Characteristics:

Assumed Losses: 1.0-inch initial abstraction + 0.05 in/hr

The following are measured from outlet of subarea to the point noted:

L = Length of Main Watercourse extended to the divide = 0.568 mile

L_{CA} = Length of Main Watercourse to the centroid = 0.292 mile

From NAB Data: AREA 11, PLATE E

Cp = 0.62

C_T = 1.5

$Tp = C_T \times (L \times L_{CA})^{0.3}$ = 0.58 (hrs)

Flow at Start of Storm = 1.5 cfs/sq. mile x Subarea D.A = 0.2 cfs

Computer Data:

QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

Remarks: _____

Data for Dam at Outlet of Subarea A3
(see Sketch on Sheet C-4)

Name of Dam: MARSHWOOD Sheet 1 of __

Height: 14 FEET (existing)

Spillway Data:	Existing Conditions	Design Conditions
Top of Dam Elevation	1540.8	1541.4
Spillway Crest Elevation	1537.0	1537.0
Spillway Head Available (ft)	3.8	4.4
Type Spillway	SHARP CRESTED CONCRETE WEIR	
"C" Value - Spillway	3.10	3.10
Crest Length - Spillway (ft)	100	100
Spillway Peak Discharge (cfs)	2296	2861
Auxiliary Spillway Crest Elevation	SEE NEXT SHEET	
Auxiliary Spillway Head Available (ft)	3.6	4.2
Type Auxiliary Spillway	CANAL	
"C" Value - Auxiliary Spillway	N/A	N/A
Crest Length - Auxiliary Spillway (ft)	25	25
Auxiliary Spillway Peak Discharge (cfs)	≈400	≈530
Combined Spillway Discharge (cfs)	≈2700	≈3390

Spillway Rating Curve:

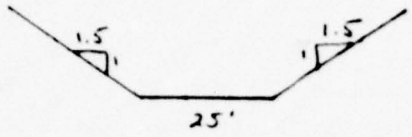
Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
	SEE FOLLOWING SHEETS		

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT Auxiliary Spillway — FILE NO.
Marshwood Dam — SHEET NO. ___ OF ___ SHEETS
FOR
COMPUTED BY ___ DATE ___ CHECKED BY ___ DATE ___

1537.2 – (FROM SURVEY FOR THIS INSPECTION)

S = .001 (FROM PLANS)



EARTH CHANNEL
$n = .025$ (CHOW)
$Q = \frac{1.486}{n} R^{2/3} A S^{1/2}$

depth (FT)	Area FT²	WP (FT)	R (FT)	Q CFS	hv = Q/A (FT)	EGL = depth + hv + 1537.2	
0	0	0	0	0	0	1537.2	
0.5	12.88	26.80	.480	15	.02	1537.7	
1.0	26.5	28.61	.926	47	.03	1538.2	
1.5	40.88	30.41	1.344	94	.04	1538.7	
2.0	56.0	32.21	1.739	152	.04	1539.2	
2.5	71.88	34.01	2.11	222	.05	1539.7	
3.0	88.50	35.82	2.471	304	.05	1540.3	
3.5	105.88	37.62	2.81	397	.06	1540.8	← EXISTING CAPACITY ≈ 400 CFS
4.0	124	39.42	3.145	500	.06	1541.3	
4.5	142.88	41.22	3.466	615	.07	1541.8	
5.0	162.5	43.03	3.777	741	.07	1542.3	
5.5	182.88	44.83	4.079	878	.07	1542.8	
6.0	204	46.63	4.375	1026	.08	1543.3	
8.0	296	53.84	5.497	1733	.09	1545.3	
10.0	400	61.06	6.55	2632	.10	1547.3	

Design elev = 1541.4 Assume hv = .06'
W.S. in Aux. spillway 1541.34 depth = 4.14'
Q = 531 cfs ≈ 530 cfs hv = .06 check OK

0818

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA

SUBJECT _____ FILE NO. _____
SHEET NO. _____ OF _____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

Spillway Rating Curve
Marshwood Dam

Pool Elev	Q Spillway CFS	Q Auxiliary Spillway CFS	Total Q CFS
1537.0	0	0	0
1537.2	28	0	28
1537.7	182	15	197
1538.2	408	47	455
1539.2	1012	152	1164
1540.3	1858	304	2162
1540.8	2296	397	≈2700
1541.4	2861	531	≈3390
1542.3	3782	741	4523
1545.3	7413	1733	9146

0515

Data for Dam at Outlet of Subarea A3

Name of Dam: MARSHWOOD Sheet 2 of __

Outlet Works Rating:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	1527.0±		
Invert of Inlet	1531.0±		
Type	CIP		
Diameter (ft) = D	1.5		
Length (ft) = L	142		
Area (sq. ft) = A	1.77		
N	.014		
K Entrance	0.5		
K Exit	1.0		
K Friction* = $29.1_N{}^2L/R^{4/3}$	2.99		
Sum of K	4.49		
$(1/K)^{0.5}$ = C	.472		
Maximum Head (ft) = HM	14.4		
Q = C A $\sqrt{2g(HM)}$ (cfs)	25		
Q Combined (cfs)	25		

* R = Hydraulic Radius = (Area/Wetted Perimeter) = D/4 for Circular Conduits.

Data for Dam at Outlet of Subarea A3

Name of Dam: MARSHWOOD Sheet 3 of __

Storage Data:

Elevation	Area (acres)	Storage million gals	Storage acre-ft	Remarks
1527.8 = ELEVO*	0	0	0	
1537 = ELEV1	37 = A1	38	116.6 = S1	
1540	39.9			
1560 **	63.6			
**				

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at ~~Top of Dam~~ NORMAL POOL is 5 percent of UNCONTROLLED watershed.

Remarks: _____

SUSQUEHANNA River Basin

Name of Stream: LITTLE ROARING BROOK

Name of Dam: MARSHWOOD

NDS ID No.: PA - 00364

DER ID No.: 35-25

Latitude: N 41° 25' 55" Longitude: W 75° 33' 45"

Drainage Area: 1.64 sq. mile

Data for Subarea: A3 (see Sketch on Sheet C-4)

Name of Dam at Outlet of Subarea: MARSHWOOD

Drainage Area of Subarea: 1.27 (UNCONTROLLED) sq. mile

Subarea Characteristics:

Assumed Losses: 1.0-inch initial abstraction + 0.05 in/hr

The following are measured from outlet of subarea to the point noted:

L = Length of Main Watercourse extended to the divide = 2.538 mile

L_{CA} = Length of Main Watercourse to the centroid = 1.089 mile

From NAB Data: AREA 11, PLATE E

Cp = 0.62

C_T = 1.50

$Tp = C_T \times (L \times L_{CA})^{0.3}$ = 2.03 (hrs)

Flow at Start of Storm = 1.5 cfs/sq. mile x Subarea D.A = 1.9 cfs

Computer Data:

QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

Remarks: _____

_____

APPENDIX C

SUMMARY UNRAISED CONDITIONS

SEE SHEET C-4

	A1 Subarea	A2 Subarea	A3 Subarea	Subarea	Total
Drainage Area (sq. mile)	.23	.14	1.27		1.64
PMF:					
Peak Outflow (cfs)	821	650	4378		
Total Runoff (inches)	-	-	-		
Dam at Outlet?	YES	YES	YES		
Is Dam Overtopped?	NO	YES	YES		
Depth of Overtopping (ft)	-				
One-Half PMF:					
Peak Outflow (cfs)	414	273	2096		
Total Runoff (inches)	-	-	-		
Dam at Outlet?	YES	YES	YES		
Is Dam Overtopped?	NO	NO	NO		
Depth of Overtopping (ft)	-	-	-		
Does Dam Fail?	NO	NO	NO		
Peak Failure Outflow (cfs)	-	-	-		
At time (hrs)	-	-	-		
Spillway (percent of PMF)	100	72	65		

DOWNSTREAM SUMMARY

	Peak Water Surface Elevation Before Failure	After Failure	Remarks
Cross Section NOT	USED		
Cross Section			
Cross Section			
Cross Section			
Cross Section			

SELECTED COMPUTER OUTPUT

ITEM	PAGE NO.
INPUT	C-21 TO C-22
SYSTEM PEAK FLOWS	C-23
SUMMARY OF DAMS:	
DUNMORE NO. 4 DAM	C-24
DUNMORE NO. 3 DAM	C-25
MARSHWOOD DAM	C-26

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**************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  11 JAN 79
**************************************
A1          DUNMORE DAMS AND MARSHWOOD DAM-GECC
A2             LITTE ROARING BROOK AND ITS TRIBUTARY
A3                MARSHWOOD DAM
B      300       0      15       0       0       0       0       0      -4       0
B1       5
J        1       4       1
J1       1      .8      .6      .5
K        0       1                                       1
K1          DUNMORE 4 RUNOFF
M        1       1     .23             1.64
P             21.5     118     127     136     142     145
T                                                        1     .05             .04
W     0.99    0.67
X     -1.5    -.05     2.0
K        1       1                                       1
K1          DUNMORE 4 ROUTING
Y                                1
Y1       1                                         -2013.7      -1
Y42013.7  2016.4  2015.1  2015.7  2016.4  2017.0  2017.7  2018.2  2019.0
Y5       0      99     282     528     829    1182    1584    1961    2568
$A       0       6    20.6
$E1998.4  2013.7    2070
$$2013.7      55     2.7     1.5
$D2016.5     2.7     1.5     600
K        1       5                                       1
K1          SECT 3 DNSTRM NO 4 DAM
Y                                1
Y1       1                                              -1
Y6     .08     .07     .08    1895    1920    4050   .0475
Y7       0    1940     310    1920     630    1900     800    1895     810    1895
Y7     960    1900    1200    1920    1600    1940
K        0       2                                       1
K1          DUNMORE 3 RUNOFF
M        1       1     .14             1.64
P             21.5     118     127     136     142     145
T                                                        1     .05              .1
W      .58     .62
X     -1.5    -.05     2.0
K        1       2                                       1
K1          DUNMORE 3 ROUTING
Y                                1
Y1       1                                           -2021      -1
Y4    2021  2021.9  2022.5  2023.2  2023.9  2024.4  2025.4
Y5       0     100     289     538     842    1050    1602
$A       0       9    26.8
$E2002.6    2021    2040
$$  2021      64    3.17     1.5
$D2022.8     2.7     1.5     700
K        1       5                                       1
K1          SECT 4 DNSTRM NO. 3 DAM
```

```
Y                                   1
Y1     1                                                   -1
Y6   .08      .07      .08       1900     1920     2750    .076
Y7     0     1950      270       1960      650     1970    1200     1900     1500     1900
Y7  2200     1920     2600       1960     2600     1920
K      ?        5                                             1
K1       COMBINE FLOW NO.5 & NO.6
K      1        6                                             1
K1       SECT 6 DNSTRM
Y                                   1
Y1     1                                                   -1
Y6   .08      .07      .09       1760     1765     1600    .081
Y7     0     1800      300       1780      670     1760     600     1760      610     1760
Y7  1200     1760     1950       1760     2600       18
K      1        8                                             1
K1       SECT 7 DNSTRM
Y                                   1
Y1     1                                                   -1
Y6   .08      .07      .09       1590     1620     3000     .05
Y7     0     1690      100       1620      300     1600     630     1590      460     1590
Y7   640     1600      410       1620     1600     1690
K      0        8                                             1
K1       MARSHWOOD UNCONTR. RUNOFF
M      1        1     1.27               1.44
P            21.5      118        127      136      162     145
T                                                             1      .05               .05
W   2.03     0.62
X   -1.5     -.05      2.0
K      2        8                                             1
K1       COMBINE MARSHWOOD INFLOW
K      1        8                                             1
K1       MARSHWOOD ROUTING
Y                                   1
Y1     1                                                -1537       -1
Y4  1537   1537.2   1537.7     1538.2   1539.2   1540.3  1540.8   1541.6   1542.3   1545.3
Y5     0       78      197        455     1166     2162    2700     3390     4523     9166
SA     0       37     39.9       63.6
SE1527.8     1537     1540       1560
SS  1537
SD1540.8      2.7      1.5        670
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 .50	RATIOS APPLIED TO FLOWS RATIO 3 .60	RATIO 4 .50
HYDROGRAPH AT	1	.23	1	885.	708.	531.	442.
	(	.60)	(	25.06)(	20.05)(	15.04)(	12.53)(
ROUTED TO	1	.23	1	821.	661.	497.	416.
	(	.60)	(	23.25)(	18.71)(	14.07)(	11.72)(
ROUTED TO	5	.23	1	805.	646.	485.	406.
	(	.60)	(	22.78)(	18.30)(	13.74)(	11.63)(
HYDROGRAPH AT	2	.14	1	666.	533.	400.	333.
	(	.36)	(	18.87)(	15.09)(	11.32)(	9.43)(
ROUTED TO	2	.14	1	658.	499.	336.	273.
	(	.36)	(	18.64)(	14.13)(	9.51)(	7.73)(
ROUTED TO	5	.14	1	621.	453.	327.	268.
	(	.36)	(	17.64)(	12.83)(	9.25)(	7.59)(
2 COMBINED	5	.37	1	1339.	1081.	799.	659.
	(	.96)	(	37.91)(	30.62)(	22.61)(	18.66)(
ROUTED TO	6	.37	1	1347.	1073.	797.	662.
	(	.96)	(	38.15)(	30.38)(	22.57)(	18.75)(
ROUTED TO	8	.37	1	1318.	1067.	795.	658.
	(	.96)	(	37.32)(	30.21)(	22.50)(	18.64)(
HYDROGRAPH AT	8	1.27	1	3261.	2608.	1956.	1630.
	(	3.29)	(	92.33)(	73.86)(	55.40)(	46.16)(
2 COMBINED	8	1.64	1	4397.	3563.	2668.	2224.
	(	4.25)	(	124.51)(	100.33)(	75.55)(	62.97)(
ROUTED TO	8	1.64	1	4378.	3690.	2535.	2096.
	(	4.25)	(	123.97)(	98.83)(	71.78)(	59.35)(

SUMMARY OF DAM SAFETY ANALYSIS

DUNMORE NO. 4 DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	2013.70	2013.70	2016.50
STORAGE	31.	33.	55.
OUTFLOW	0.	0.	858.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	2016.38	0.00	53.	821.	0.00	40.75	0.00
.80	2016.01	0.00	49.	661.	0.00	40.75	0.00
.60	2015.62	0.00	45.	497.	0.00	40.75	0.00
.50	2015.42	0.00	44.	416.	0.00	40.75	0.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	805.	1897.0	41.00
.80	646.	1896.8	41.00
.60	485.	1896.6	41.00
.50	404.	1896.5	41.00

SUMMARY OF DAM SAFETY ANALYSIS

DUNMORE No. 3 DAM

PLAN 1 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	2021.00	2021.00	2022.80
STORAGE	55.	55.	73.
OUTFLOW	0.	0.	595.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	2023.01	.21	75.	658.	1.25	40.75	0.00
.80	2022.91	.11	74.	599.	.75	40.50	0.00
.60	2022.83	0.00	71.	536.	0.00	40.50	0.00
.50	2022.66	0.00	69.	273.	0.00	40.50	0.00

PLAN 1 STATION 5

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	623.	1900.9	40.50
.80	453.	1900.6	40.75
.60	327.	1900.4	40.75
.50	268.	1900.4	40.75

PLAN 1 STATION 6

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1347.	1760.3	40.75
.80	1073.	1760.2	40.75
.60	797.	1760.2	41.00
.50	662.	1760.1	41.00

PLAN 1 STATION 8

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	1319.	1593.1	41.00
.80	1067.	1592.8	41.00
.60	795.	1592.4	41.00
.50	658.	1592.2	41.00

SUMMARY OF DAM SAFETY ANALYSIS

MARSHWOOD DAM

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	1537.00	1537.00	1560.00
STORAGE	111.	113.	261.
OUTFLOW	0.	0.	2700.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1561.56	.76	292.	6378.	5.25	41.50	0.00
.80	1561.20	.60	278.	3490.	2.25	41.75	0.00
.60	1560.65	0.00	255.	2555.	0.00	41.75	0.00
.50	1560.23	0.00	238.	2096.	0.00	42.00	0.00

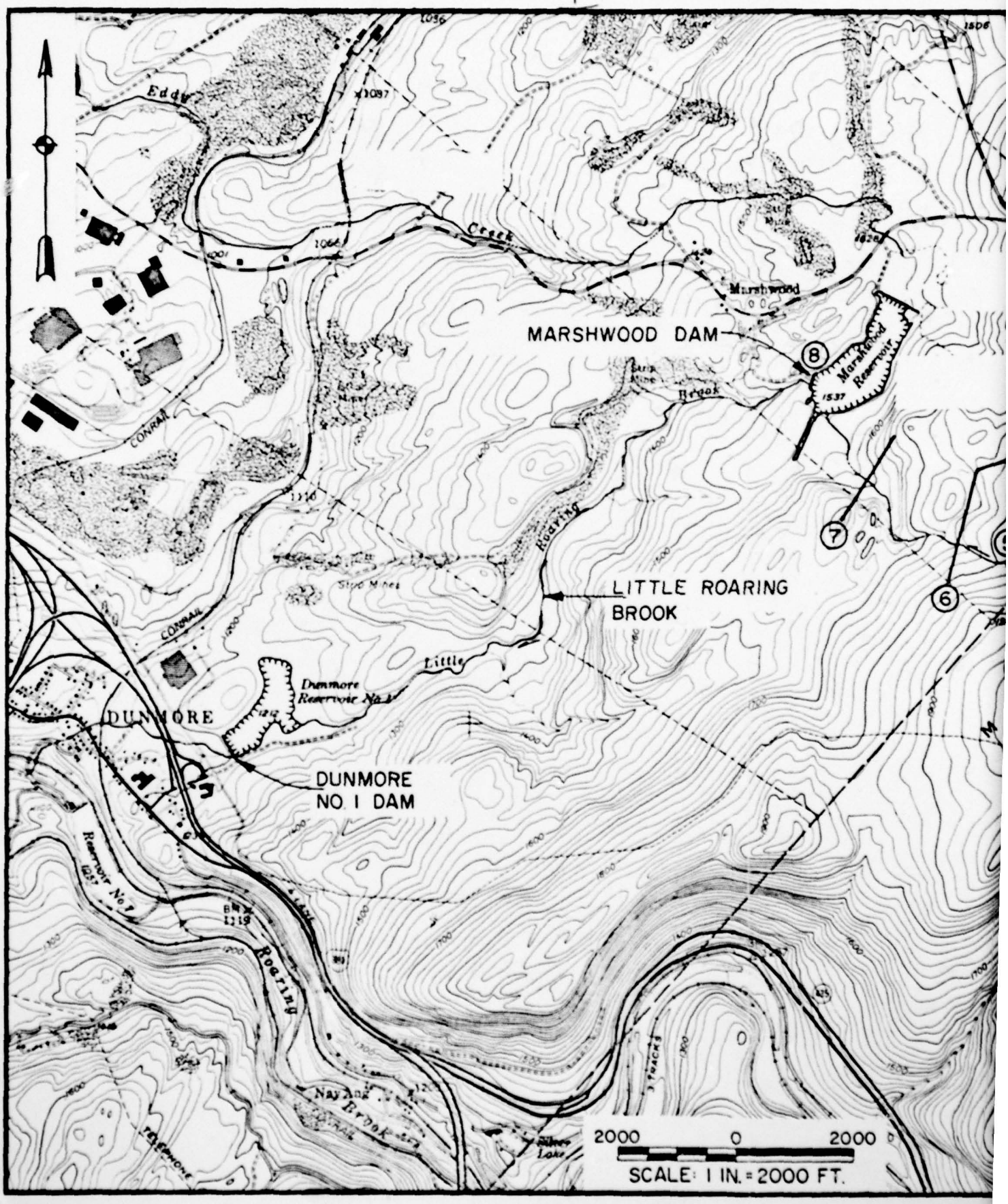
GANNETT FLEMING CORDDRY
AND CARPENTER, INC.
HARRISBURG, PA.

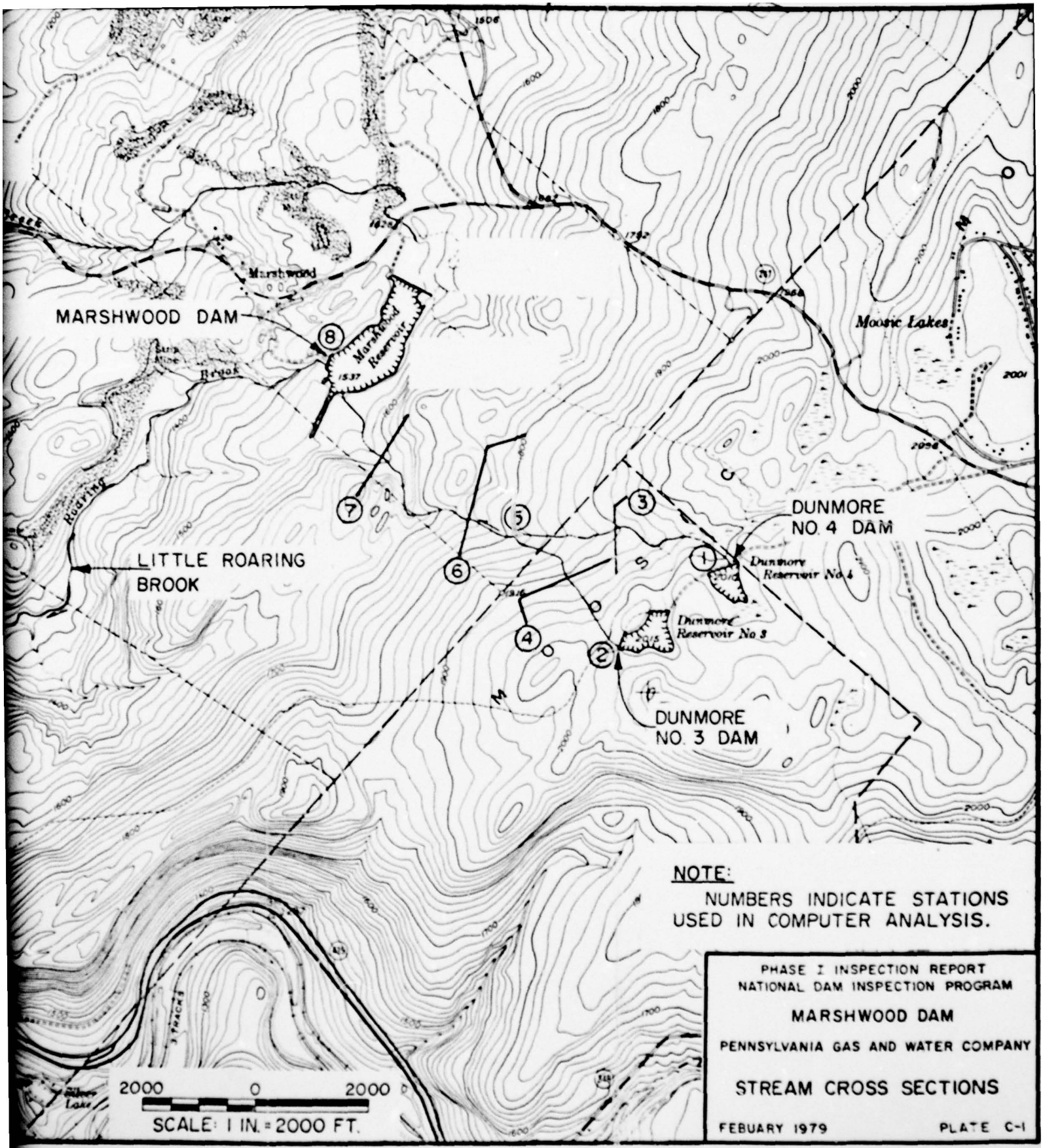
SUBJECT _____ FILE NO. _____
SHEET NO. ____ OF ____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

SUMMARY OF RESULTS
(DAM WITH EXISTING CONDITIONS)

PMF RAINFALL = 24.9"

	PMF	½ PMF
RUNOFF (INCHES)	22.5	11.3
MARSHWOOD DAM:		
PEAK INFLOW (CFS)	4,397	2,224
PEAK OUTFLOW (CFS)	4,378	2,096
DEPTH OF OVERTOPPING (FT)	0.74	—


MARSHWOOD DAM
LITTLE ROARING BROOK
DUNMORE NO. 1 DAM
DUNMORE
Marshwood Reservoir
Dunmore Reservoir No. 1
Reservoir No. 2
Eddy
Creek
Roaring
Little
CONRAIL
Nay Aug Brook
Silver Lake
2000 0 2000
SCALE: 1 IN. = 2000 FT.



NOTE:
NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MARSHWOOD DAM

PENNSYLVANIA GAS AND WATER COMPANY

STREAM CROSS SECTIONS

FEBUARY 1979 PLATE C-1

AD-A078 968 GANNETT FLEMING CORDDRY AND CARPENTER INC HARRISBURG PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. MARSHWOOD DAM (NDI ID NUMBER P--ETC(U)
FEB 79 DACW31-79-C-0015

UNCLASSIFIED NL

2 OF 2
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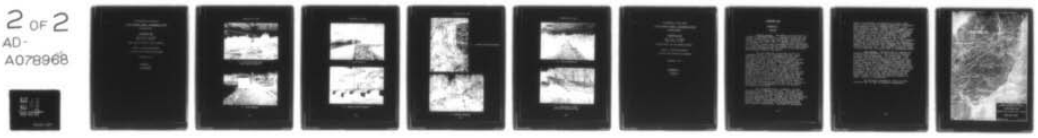

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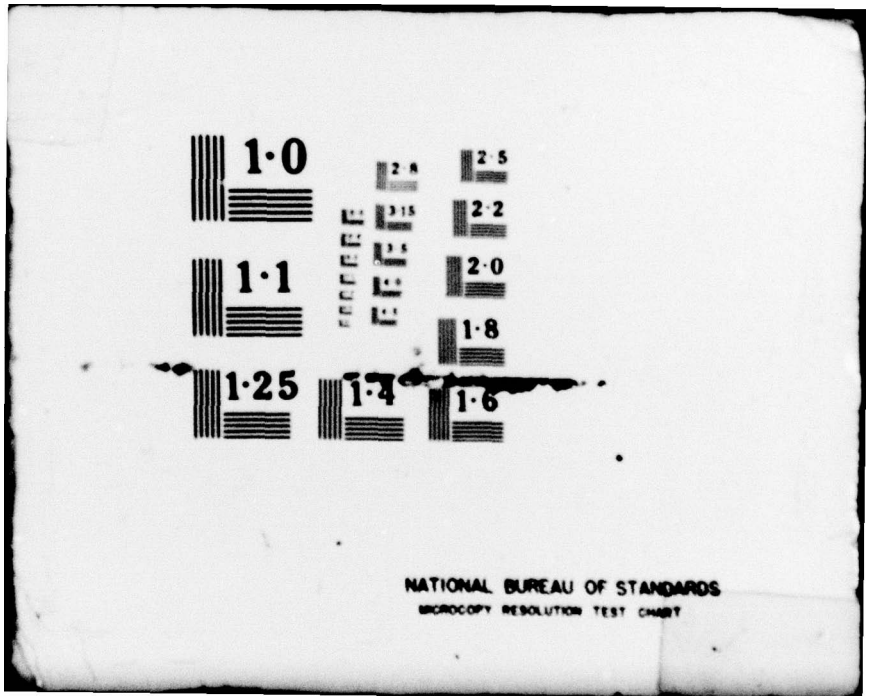
1·0
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NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

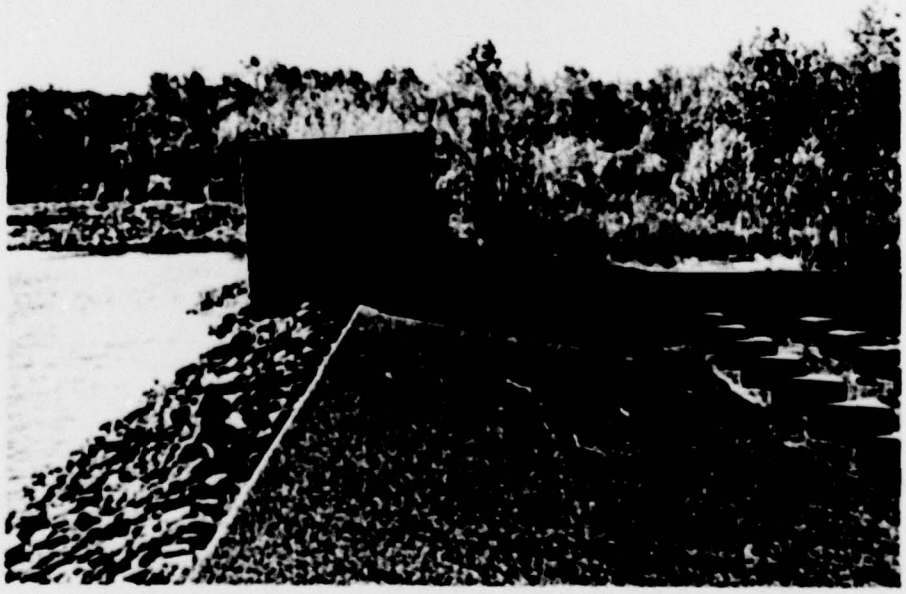
NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

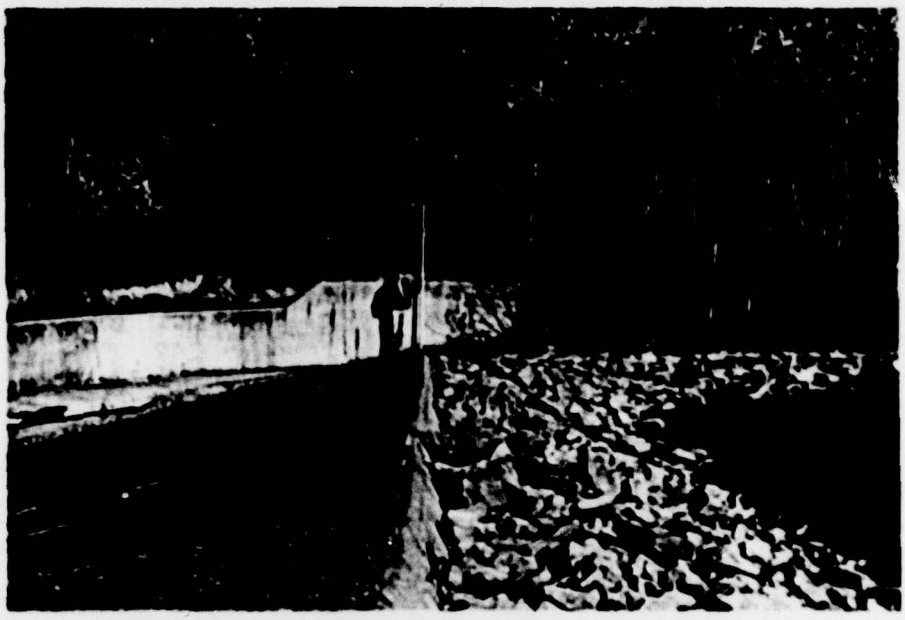
APPENDIX D

PHOTOGRAPHS

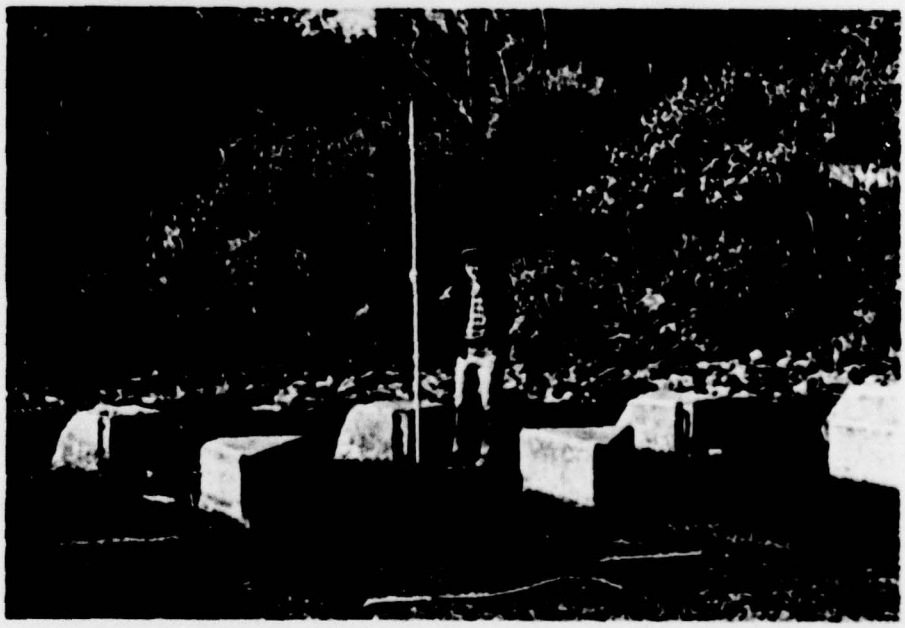
A. South Embankment and
Main Spillway Approach



B. Main Spillway



C. Main Spillway



D. Spillway Outlet Channel

E. Gouge in South Embankment

F. Auxiliary Spillway

G. North Embankment

H. Dunmore No. 4 Dam
Upstream of Marshwood Dam

SUSQUEHANNA RIVER BASIN

LITTLE ROARING BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

MARSHWOOD DAM

NDI ID No. PA-00365
DER ID No. 35-88

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

APPENDIX E

GEOLOGY

MARSHWOOD DAM

APPENDIX E

GEOLOGY

1. General Geology. The damsite and reservoir are located in Lackawanna County. Lackawanna County was completely covered with ice during the last continental glaciation of Pleistocene time. The general direction of ice movement was S 35° - 40° W. Glacial drift covers the entire County, except where subsequent erosion has removed it. Thick deposits of glacial outwash occur in many places along the Lackawanna River, and are 50 to 100 feet thick near Dickson, Scranton, and Moosic.

The only important structural feature in Lackawanna County is the Lackawanna Syncline, which traverses the County in a southwesterly direction. The syncline enters the County at the northeast corner as a narrow shallow trough, gradually deepens and broadens toward the southwest, and reaches its maximum development in Luzerne County. The rock formations exposed range from the post-Pottsville formations (youngest) through the Pottsville, Mauch Chunk shale, Pocono sandstone to the Damascus formation of the Catskill group (oldest). The rim rocks, the Pottsville formation and Pocono sandstone, have dips that rarely exceed 10° to 20° and form a rather simple syncline. The core rocks, the post-Pottsville formations, are folded into a series of minor anticlines and synclines which trend about N 70° E. The rocks in the northwestern and southeastern parts of the County, outside of the limits of the Lackawanna Syncline, are generally horizontally stratified.

The Lackawanna River, in general, follows the axis of the Lackawanna Syncline. Southeast of the Lackawanna River, the rise in terrain is quite gradual and the crests of the high mountains are several miles from the Lackawanna River. Streams, such as Roaring Brook, Stafford Meadow Brook, and Spring Brook, have cut deep canyons through the mountains and follow a tortuous course to their confluence with the Lackawanna River near Scranton, Pennsylvania. Northwest of Lackawanna

River, the mountains rise abruptly to a sharp ridge which in most places is somewhat higher than the country flows westward by way of Tunkhannock Creek. A few small tributary streams, however, such as Leggetts Creek, flow eastward from this area into the Lackawanna River. In the area of interest, the Lackawanna River streambed is founded in post-Pottsville formations. Proceeding uphill from the river, the older Pottsville formation, Mauch Chunk shale, Pocono sandstone, and Catskill continental group are encountered in turn. The tributary streams, in flowing down the mountains, have generally cut through or around the hard sandstone and conglomerate members, and have eroded their streambed into the softer shales and glacial till. The Catskill continental group of rocks underlies the greater part of Lackawanna County.

2. Site Geology. Marshwood Dam is underlain by sandstones and siltstones of the Pottsville formation of early Pennsylvanian age. The rocks strike to the northeast and dip moderately to the northwest. The Pottsville formation is composed of light to dark gray, fine grained to coarsely conglomeratic sandstone; gray shales, limestone and coal. Bedding is generally well developed ranging in thickness from thin shale laminate to several feet in the sandstones. Two systematic joint sets in the area trend approximately N 20 E. and N 45 W. A series of small anticlinal and synclinal structures are present in this area. These structures are discontinuous and are seldom more than a few miles in length. Rocks in the area are generally moderate to highly resistant to weathering.

The available information, which is scant, indicates that the dam is founded on overburden.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

MARSHWOOD DAM

PENNSYLVANIA GAS AND WATER COMPANY

GEOLOGIC MAP

FEBUARY 1979 PLATE E-1